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JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

VOLUME 30, 1940

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PUBLISHED MONTHLY
BY THE
WASHINGTON ACADEMY OF SCIENCES
450 Ahnaip St.
at Menasha, Wisconsin

ACTUAL DATES OF PUBLICATION, VOLUME 30

No 1, pp 1–48, January 16, 1940
No. 2, pp. 49–92, February 9, 1940.
No. 3, pp 93–136, March 9, 1940.
No 4, pp 137–184, April 18, 1940
No 5, pp. 185–232, May 14, 1940.
No. 6, pp. 233–276, June 10, 1940.
No. 7, pp 277–320, July 10, 1940.
No 8, pp. 321–364, August 8, 1940
No 9, pp. 365–412, September 14, 1940.
No 10, pp. 413–456, October 14, 1940.
No. 11, pp. 457–500, November 15, 1940.
No. 12, pp 501–548, December 16, 1940

JOURNAL
OF THE
WASHINGTON ACADEMY OF SCIENCES

VOL 30 JANUARY 15, 1940 NO 1

ANTHROPOLOGY —*Prehistoric culture waves from Asia to America*[1]

DIAMOND JENNESS, National Museum of Canada, Ottawa, Canada (Communicated by H B Collins, Jr)

The recent excavations of Collins on St Lawrence Island and at other places around the Bering Sea[2] seem to bring out one very important point, viz , that there has been no extensive migration across Bering Strait unless it be of Eskimo since the early centuries of the Christian Era The Eskimo culture strata in that region show no profound disturbance such as one would expect from an invading horde, but rather a gradual change stimulated to some extent by Asiatic as well as strictly American influences, but not by the intrusion of an alien people Now Nordenskiold and others[3] have proved that although a few Polynesians may on one or more occasions have reached the shores of America, there has never been any transoceanic migration large enough to affect profoundly the physical composition of the aborigines in the New World or the evolution of their cultures We can rule out likewise any immigration by way of Kamchatka and the Aleutian Archipelago if for no other reason than that the archipelago has yielded no traces of earlier remains than those of the Aleutian Eskimo, who undoubtedly reached their home from America Bering Strait, therefore, was the only route of ingress into this hemisphere, and the forefathers of every known division of Indians must already have crossed this strait by the beginning of the Christian Era

This conclusion harmonizes well with the results of linguistic studies Hitherto we have utterly failed to link up any American Indian language with any language or group of languages in the Old

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[1] Address of the retiring president of the American Anthropological Association delivered at Chicago, Ill on December 29 1939

[2] COLLINS H B Archaeology of St Lawrence Island, Smithsonian Misc Coll 96(1) 1937

[3] Cf NORDENSKIÖLD E Origin of the Indian civilizations in South America Comparative Ethnographical Studies 9 1931

DIXON, ROLAND B The long voyages of the Polynesians Proc Amer Phil Soc 74(3) 167–175 1934

World. Thus Rivet's effort to connect the Hokan dialects of California with Malayo-Polynesian, and some Patagonian languages with Australian, has apparently found few supporters. Some day we may succeed in joining up Eskimo with the Ural-Altaic languages and in proving that the Athapaskan or Déné tongues of North America are genetically related to the Sinitic tongues of eastern Asia. Such relationships, however, even if confirmed, must be exceedingly distant, for we know how little the Greenlandic Eskimo dialects have diverged from the north Alaska ones, despite a separation of 1,000 years, and how small is the difference, after an equally long separation, between the Navaho Indian dialect in the Southwest of the United States and the dialects spoken in the Mackenzie River Basin. Probably much of the linguistic diversity among the Indians and Eskimo took place in Asia before their entry into the New World; but the fact that *no* American tongue is palpably related to any Asiatic one strongly suggests that the inhabitants of the New World, barring the Eskimo to whom I will return later, separated off completely from those of the Old more than 2,000 years ago.

On ethnological grounds, too, there seems no reason to question this conclusion, because the traits that are common to Asia and America, apart from a few that are concentrated near the bridge-head at Bering Strait, are so widely diffused in both continents that they evidently carry a very respectable antiquity. Even the resemblances between the Palae-Asiatics and the Indians of the northwest coast of America hardly demand a migration in post-Christian times. If there was such a migration it is more likely to have been from America to Asia by way of the Aleutians and Kamchatka, as Collins has shown,[4] than from Asia to America; moreover, it was a relatively insignificant migration that introduced into northeast Asia a few cultural traits such as labrets, certain forms of stone lamps, a certain type of house, and perhaps some folk tales, but failed to effect any far-reaching changes. It can hardly account for the much deeper resemblances, e.g., in physical type and clothing, between the Palae-Asiatics and some of the American Indians.

For the millennia that preceded the Christian Era, the millennia that saw the peopling and subsequent isolation of America, archeology, our safest guide, has afforded us hitherto only one or two uncertain clues. The main props for our theories have come from ethnology, linguistics, and physical anthropology, none of which can furnish more than the vaguest indications of a time sequence. In founding our theories on these disciplines we are building on shifting sand, and we need not be surprised if the theories topple over when the spades of the archeologists succeed in uncovering new and possibly unexpected remains.

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[4] COLLINS, H. B., op. cit., pp. 375–378. Also Culture migrations and contacts in the Bering Sea region. Amer. Anthrop. 39(3): 375–384. 1937.

The geographical position of the Athapaskan Indian tribes along the pathway from Bering Strait toward the Equator, the late date (about 1000 A.D.) when their advance columns reached the Southwest of the United States, the comparatively minor changes in their dialects from the Mackenzie Delta to Arizona, and the still demonstrable affinity of their language (if we may trust Sapir) to the Sinitic tongues of eastern Asia, all suggest that their movement into America did not long precede the Christian Era. There are faint indications that they may have entered this continent, or at least have advanced south from Alaska, in two waves, one considerably earlier than the other; for it is noticeable that the most divergent or archaic-seeming dialects (e.g., Haida and Tsetsaut) lie on the west side of the Rockies, where the snowshoe and the wooden toboggan so omnipresent in the Mackenzie River Basin seem to have been unknown in pre-European times. There are faint indications, also, that their irruption into the Mackenzie River Basin created a considerable displacement of other peoples who were occupying this region at the time, or were located on its outskirts.[5] A recent botanical investigation by Dr. Raup suggests that the grasslands of the Peace River area, perhaps too the forest zone along the northern edge of the plains, was muskeg land or tundra no longer ago than 2,000 or 3,000 years, and that the present-day bison and moose were preceded by herds of caribou. Presumably, the Eskimo of those days extended much farther south than they do now and were pushed eastward and northeastward by the invading Athapaskans. I incline to think that it was at this period the Caribou Eskimo were restricted to their present home on the Barren Lands west of Hudson Bay; and that a kindred group of Eskimo fugitives occupied the coasts of the eastern Arctic, where they developed that mysterious Dorset culture, which extended in prehistoric times from Newfoundland to Greenland.

In addition to driving out the Eskimo, the Athapaskans may have dislodged some Algonkian tribes, as Birket-Smith believes, and started them on a movement that carried them into the Labrador Peninsula. Certainly the traditions of these Montagnais and Naskapi

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[5] Cf. BIRKET-SMITH, Kaj. Folk-wanderings and culture drifts in northern North America. Journ. Soc. Americanistes Paris, n.s., 22: 26-29. 1930.

Indians bring them from the west, and the strange stone culture discovered by Strong near Nain,[6] on the Labrador coast, despite its distinctly Algonkian flavor, seems so alien to them that we may ascribe it tentatively perhaps to some early group that was later absorbed or destroyed by other Algonkians, as were the now-extinct Beothuk Indians of Newfoundland.

I am more reluctant to follow Birket-Smith in attributing to the Salish Indians of British Columbia an early home on the Canadian plains from which they were driven westward by the Athapaskans, because so many traits in Salish culture point to a southern rather than a plains' origin, and their language, even should it prove to be Algonkian, as Sapir suggests, differs so widely from Blackfoot, Cree, and other members of that linguistic stock that it surely indicates a very long separation. Nevertheless, we must not overlook the possibility that the Salish Indians may have a dual origin, that they may be an amalgamation of two groups, one of which came originally from the south, and the other from the Canadian plains.

Shapiro and Seltzer[7] have pointed out the marked resemblance in physical type between the northeastern Algonkians (including the Hurons, who absorbed many Algonkians into their ranks), the Chipewyan Indians of Lake Athabasca, and large groups of Arctic Eskimo, particularly those in Coronation Gulf, Smith Sound, and Seward Peninsula. Now we know that at least the Coronation Gulf Eskimo, like those of Hudson Bay, dwelt inland only a few centuries ago. Hence physical anthropology also seems to indicate that the Eskimo and Algonkians formerly lived in such close contact, somewhere in the heart of Canada, that either the Eskimo freely took Algonkian wives or certain Algonkian groups adopted the Eskimo culture, and, under pressure from the invading Athapaskans, moved northward to the Arctic coast.

It is idle to speculate on the Asiatic home of the Athapaskans or the route they followed to Bering Strait. Even archeology may never be able to throw light on this question, because the majority of their tools and weapons had blades and points of bone rather than of stone, and bone disintegrates very rapidly. This, at least, is true of Canada. In Alaska there seems to be a greater wealth of stone implements, and there too we find pottery as far up the Yukon River as the mouth of the Tanana. Both these traits, however, may well be due to Eskimo influence, since no other American Athapaskan tribe was acquainted with pottery unless it bordered on a pottery-using people.

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[6] STRONG, W. D. A stone culture from northern Labrador and its relation to the Eskimo-like cultures of the northeast Amer Anthrop 32: 126–144 1934 Cf the review by WINTEMBERG, W J, in Geogr. Rev, Oct., 1930, p 673

[7] SHAPIRO, H L. The Alaskan Eskimo Anthrop. Pap Amer. Mus Nat Hist. 31(pt 6) 1931; The origin of the Eskimo Proc 5th Pacific Sci. Congr 4: 2723–2732. 1933

SELTZER, CARL C. The anthropometry of the western and copper Eskimos. Human Biol. 5(3): 312–370. 1933.

We may assume, then, until evidence to the contrary is forthcoming, that hordes of Athapaskan-speaking peoples crossed Bering Strait some time in the first millennium B.C. and forced their way southward, some by way of the Mackenzie River, others down the western slopes of the Rockies until they reached Colorado, Arizona, and New Mexico. It was they, perhaps, who introduced bows and arrows and the Mongoloid strain in Pueblo I remains, shortly before the end of the first millennium A.D.; they, too, who introduced the snowshoe and other important elements into America, as Birket-Smith cogently argues—though I find it difficult to ascribe to an Athapaskan invasion all the elements he includes in the snowshoe complex, particularly hunting territories, which I suspect are post-European, and moccasins, cradle-boards, bark vessels, and the use of fatty substances for tanning skins, since these elements occur also in the extreme south of South America.

Inseparably linked with the Athapaskan invasion are the Eskimo, whom they partly dislodged, and the Indians of the northwest Pacific coast, the "totem-pole" Indians whose origin and culture still remain a profound mystery.

Let us consider the latter first. Smith's excavations in the shell-heaps along this Pacific coast have yielded rather negative results, although the forest growth proves that some of the heaps were abandoned at least 500 years ago and that their lowest levels must be several hundred years older. They revealed that there was a long-headed strain in the population that is absent in the modern Indians of the region; also that a few implements had a somewhat restricted range, being absent either in the more northern heaps, or in the more southern. By and large, however, there was little or no indication of any earlier culture than that which was still flourishing along this coast in the nineteenth century, although it was originally somewhat simpler, and more nearly related, apparently, to that found inland up the Fraser River. Even in the first millennium A.D., then, it was apparently well rooted in its present home.

As far as their physical type is concerned, the modern Indians of this area are indistinguishable, Hrdlička states, from the Gilyak and other tribes on the Amur River in Siberia; but the affinities of the earlier, long-headed strain are uncertain.

Linguistic studies indicate that Haida and Tlinkit are greatly modified forms of Athapaskan or Déné, that Tsimshian is a Penutian tongue related to some languages in California, while the three southern languages, Kwakiutl, Nootka, and Salish, may ultimately prove to belong to the Algonkian linguistic stock. This helps our present enquiry very little, except that it suggests a pressure of Athapaskan tribes in the north strong enough to impose the language but not to alter the physical type; and since the Haida and Tlinkit languages are so unlike each other, and so unlike other Déné tongues, it suggests also that they originate from the earliest Athapaskan wave and have undergone considerable changes since, partly owing to their isolation and partly to the influence of neighboring tongues.

The evidence of ethnology is rather confusing. Several traits, notably weaving with loom and spindle, the sib and moiety system, and the chewing of "tobacco" with lime, suggest a linkage with the south and middle America. Others may have developed locally, e.g., plank houses, special types of twined basketry, the caste stratification, and the peculiar style of art. A few traits lead us northward; thus the whaling practices of the Nootka, and the decorated lamplike vessels of stone that were made by the Coast Salish, find their nearest if not their only parallels among the Eskimo. Several traits, however, carry us beyond the Eskimo right into Asia. There is slat armor, distributed almost continuously through Bering Strait (where it was used in the first millennium A.D.) to Japan and China; woven hats, a definitely Asiatic trait; curved fish knives, which recall East Asiatic curved knives as well as the Eskimo *ulo;* a musical style that seems altogether different from that of other American Indians, but, according to Barbeau,[8] so strongly Asiatic that certain songs practically coincide with northeastern Siberian ones, while others closely resemble Chinese Buddhist chants; and a social organization based on wealth rather than on descent or prowess as elsewhere in America, an organization that expressed itself outwardly in a potlatch system strongly reminiscent of Indonesia and Melanesia, and in totem poles and grave monuments that, despite profound differences, instinctively draw our eyes to the grave posts on the Amur River. Even the unique art of this northwest coast may offer a clue, because, as Collins[9] has pointed out, its eye designs resemble those of the mysterious Old Bering Sea Eskimo and also the eye designs on Chinese Shang Dynasty bronzes of the second millennium B.C. Finally, we have such close parallels in mythology between the northwest Indians and the Palae-Asiatic tribes of Siberia that Jochelson went so far as to postulate a backward movement of tribes from America into northeastern Asia.

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[8] BARBEAU, MARIUS The Siberian origin of our north-western Indians Proc. 5th Pacific Sci Congr 4: 2781–2784 1933

[9] COLLINS, H B Op cit, p 298.

We might also add in this connection two other elements not found on the Pacific coast itself but present among the Interior Salish Indians of the Fraser River Basin. One is the torpedo-shaped bark canoe, known elsewhere only from the Amur River in Siberia. The other is the semiunderground house, distributed all round the north Pacific basin from China to the Southwest of the United States but in so many forms that the genetic relationship of them all is still uncertain.

We do not know, of course, the relative ages of all these traits common to Asia and the northwest coast of America. Some may be comparatively modern, others very old. Some may have spread by slow diffusion, just as tubular pipes and the tobacco *Nicotiana attenuata* spread northward and reached the Fraser River only a short time before European occupation; others, again, may have been carried by a mass migration. Two or three of them, however, notably the social organization based on wealth, the talent for sculpture, and the music (if this is confirmed) appear so deeply seated that almost involuntarily we associate them with some invading people, a people whose original home lay somewhere, perhaps, around the Amur River. Yet whether such an invasion ever did take place, and, if so, whether it preceded or followed the Athapaskan invasion, must remain unsettled until we know more of the archeology of the north Pacific coast of America and also of northeastern Asia.

Archeology has made more progress with the Eskimo, the other people who appear to have been influenced by the Athapaskan invasion. Here I should like to pay tribute to the magnificent work of Danish scholars, not only the brilliant galaxy still living but to the long line of their predecessors, from Hans Egede in the eighteenth century, Henry Rink in the nineteenth, to the last and in some respects the greatest of them, the late Knud Rasmussen. Thanks largely to Danish researches, supplemented by those of the Smithsonian Institution in Washington, we know that behind the modern Eskimo cultures there are three ancient ones, the Old Bering Sea in the west, the Thule, which originated in the west but spread over Arctic America to Greenland, and the Dorset, which was restricted to the eastern Arctic. The origins of all three cultures still await the results of further excavations in both the east and the west. Tentatively, however, I should advance the following hypotheses, in the hope that they may stimulate and guide the workers of the future.

In spite of suggestions to the contrary, I still believe that the third culture, the Dorset, is a genuine Eskimo one that has absorbed certain Indian traits, rather than an Indian culture that has Eskimoized itself, for the reason that we know of no Eskimo culture except the Thule that could have influenced it, and many of its non-Indian traits are equally non-Thule. Of special significance is the fact that a few of these traits seem to hark back to a very early Eskimo stage, because we have no parallels to them except in the far west. Collins[10] has already pointed out that in the Dorset, as in the ancient Aleutian and Old Bering Sea cultures of western Alaska, chipped stone implements immeasurably outnumber those implements of polished slate that are so characteristic of Thule and later times; also that Dorset art represents a fairly close approach to Old Bering Sea style I.

Let us examine these early eastern and western cultures more closely. In both the Dorset and the Old Bering Sea, but not in later remains, we find incurved side scrapers and trapezoidal knives of chipped chert, small slate implements with rubbed edges[11] that may have been boot creasers, and rubbing stones of polished crystalline rock, quartz in the east and basalt in the west. From an Aleutian shell-heap, again, Hrdlička has brought back such typical Dorset types as small leaf-shaped blades notched on each side of the base, knives with curving edges like miniature hunting-knives, and points with concave bases, the only difference being that the Aleutian specimens are chipped from crude basalt instead of the more amenable chert and quartz. One Aleutian knife (?) even has three notches on each side of the base, as we find on a few Dorset specimens also.[12]

Now we must not forget that in addition to these special forms known only from the east and the far west, the Dorset culture possesses many other old Eskimo traits, such as toggle harpoon heads, eyed needles and tubular needle cases, chipped end-scrapers, polished stone adz heads and adzlike scrapers, barbed bone fish-spear points, stone lamps and pots, and even "jumping stones."[13] It is true that some of these objects have peculiar shapes, but there are others hardly distinguishable from Eskimo types elsewhere. Furthermore, the Dorset people possessed in full measure the skill of other Eskimo in carving bone and ivory, for in 1937 Rowley brought back from Iglulik, on the northwest coast of Hudson Bay, some excellent figurines of Dorset manufacture that rival in workmanship similar figurines from any period of Eskimo history.

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[10] COLLINS, H. B. Op. cit., p. 373.

[11] In the Dorset culture implements of both slate and chert.

[12] At Kachemak Bay de Laguna found the following Dorset types: planing adz blade, chipped asymmetric knife blade with notched tang, one type of harpoon head, needle, and dart heads barbed symmetrically and asymmetrically on both sides. (FREDERICA DE LAGUNA, Archaeology of Cook Inlet, Alaska, p. 213, 1934.)

[13] "Jumping stones" have been discovered in Newfoundland and, more recently, inland from Hudson Bay, in the territory of the Caribou Eskimo.

In view of all this, are we not justified in suspecting, not merely that the Dorset culture is genuinely Eskimo, but that it has stemmed from the same parent trunk as the ancient cultures of western Alaska?

If we accept this reasoning, then we must believe that the ancestors of the Dorset people separated from the western Eskimo before the flowering of the Old Bering Sea culture about the beginning of the Christian Era. This would date their entry into Canada not later than the first millennium B.C., and possibly even in the second millennium. The closing centuries of the second millennium B.C. appear in fact the more probable if, as I have already suggested, it was an invasion of Athapaskan tribes that pushed the Dorset people out to the coast of the eastern Arctic; for the Athapaskans themselves, as we have seen, must have crossed Bering Strait from Asia before the Christian Era.

Collins[14] has already pointed out certain features in which the Dorset Eskimo influenced later cultures in the eastern Canadian Arctic and in Greenland. He has shown that the modern form of the eastern harpoon head, with its bifurcated base and line holes on the upper surface, is probably derived from a Dorset type; also that Solberg's Stone Age culture in northwest Greenland represents a mixture of Dorset and Thule elements. Even the physical characteristics of the Greenland Eskimo may have been modified by Dorset admixture, since Greenland Eskimo skulls (outside of Smith Sound) resemble those of the old Birnirk Eskimo in the western Arctic (who were the immediate successors, if not the actual contemporaries of the Old Bering Sea people), more than they do Thule skulls from the eastern Arctic, or the skulls of Thule descendants in Smith Sound, Southampton Island, and Barrow.[15]

Let us turn our eyes again to the western Arctic, where Collins has so brilliantly deciphered the Old Bering Sea culture and traced its evolution, or devolution, down to modern times. The Birnirk phase of Barrow appears in his sequence as the immediate successor of the Old Bering Sea, marking the beginning of the Punuk culture. It seems rather strange, however, that its characteristic harpoon heads are made of bone instead of the usual ivory, and that they are rarely if ever decorated. Like the later Thule-type harpoon heads also present on St. Lawrence Island, they rest there uneasily as if they were intruders and did not belong to the strict order of succession, Old Bering Sea, Punuk, and modern. One wonders, too, why the Old Bering Sea art should have undergone a slow and gradual modification on St. Lawrence Island all through Punuk times, century after century, whereas at Barrow it vanished completely in the Birnirk stage.

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[14] COLLINS, H B. Op cit, pp. 315, 336

[15] Cf FISCHER-MØLLER, K Skeletal remains of the central Eskimos Rep 5th Thule Exped. 3(1) 1937; and Skeletons from ancient Greenland graves Medd. Grønland 119(4) 1938

Can it be that the St. Lawrence material is slightly misleading? The Birnirk (and its first-born child the Thule) is perhaps *not* a direct offspring of the Old Bering Sea, but both may be offspring of some less advanced culture that flourished on the northeast coast of Siberia around the mouths of the Kolyma and Indigirka Rivers. From this region the hypothetical parent culture may have sent its offspring eastward. One branch crossed over Bering Strait and proceeded north along the Alaskan coast to Barrow, blazing a trail that was followed by trading parties in later centuries; it still maintained connections with the south, however, since Geist[16] found a whetstone of Kobuk River nephrite in Old Bering Sea remains on St. Lawrence Island. The other branch colonized the coastline of Siberia southward from East Cape and either then or later established a few outposts on St. Lawrence Island. Subsequently, I suspect, the southern colony on the Siberian shore below Bering Strait, powerfully stimulated by a yet more southern source (ultimately, it may be, from China), revolutionized its style of art, and acquired perhaps some new elements, such as pottery and the bow drill, that appear to have been unknown in the still earlier period I hinted at before, the period when the ancestors of the Dorset people first crossed Bering Strait onto Alaskan soil and pushed into the heart of North America.

The reader may say, perhaps, that, like a fecund rabbit, I have already delivered too large a brood of unsubstantiated theories (some of them possibly still-born). Nevertheless I hope he will pardon me if I add one more progeny to the overabundant litter.

In Old Bering Sea remains on St. Lawrence Island Collins found many dog skulls that had been broken for their brains; and the dogs were of a smaller breed than those of Punuk and later times. Furthermore, objects associated with dog traction, such as toggles, flat bone sled-shoes, and whip ferrules, did not appear until the close of the Punuk period, or roughly 200 years ago, so that evidently the St. Lawrence islanders throughout most of their history never used dogs to drag their heavy-runner sleds. In the eastern Arctic, however, Mathiassen found numerous dog-harness toggles in Thule remains dating back 1,000 years or so; and the dogs that wore this harness doubtless belonged to that rather large and heavy breed so prevalent in the eastern Arctic today. Moreover, the Thule Eskimo, like the modern, seldom or never ate them, for Mathiassen remarked no broken dog skulls in any Thule site. No dog bones have yet been recovered from an unmixed Dorset site, nor have we found any sled toggles or harness toggles, though there are some flat, bone sled-runners. We read in Frobisher's Voyages,[17] however, that in the sixteenth century the Eskimo of Frobisher Bay, in the heart of the old Dorset range at the eastern entrance to Hudson Strait, kept two distinct breeds of dogs, a smaller one for eating and a larger one for dragging the sleds.

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[16] GEIST and RAINEY. Archaeological excavations at Kukulik, St. Lawrence Island, Alaska Misc. Publ. Univ. Alaska 2: 190. 1936.

How are we to explain these facts? It seems to me quite possible that dog traction was unknown to the earliest Eskimo who reached America, not only to those who remained in Alaska, but to those too who pushed eastward into Canada and later spawned the Dorset people, and perhaps also the modern Caribou Eskimo. Both groups alike, however, kept a small breed of dog for hunting and for eating. Then, about the end of the Birnirk phase at Barrow, some time in the first millennium A.D., a larger, sturdier breed of dog was introduced into Arctic America from Siberia, where dog traction, if not earlier than reindeer traction, arose as a substitute. About the same time, too, whaling originated in the same region or was introduced from Siberia also. Under the combined impulses of dog traction and whaling certain bands of these north Alaskan Eskimo trekked eastward, carrying their Thule culture with them; and in the eastern Arctic they encountered and merged with the Dorset people. Dog traction then became general throughout the whole of the Arctic, though St. Lawrence Island, being in a kind of back eddy, did not receive it until rather late. The smaller breed of dog in the west and east became extinct, but in Frobisher Bay a mixed group of Thule and Dorset Eskimo retained and ate it down to the sixteenth century, when it disappeared there also.

[17] The three voyages of Martin Frobisher, pp. 136–137. Hakluyt Society, London, 1876.

You will note that I have pictured the original homeland of the Eskimo, not in America, but in northeast Siberia about the mouths of the Kolyma and Indigirka Rivers. It would not surprise me if it were in this region, rather than in northern Alaska, that the Birnirk culture evolved, and even the subsequent Thule. Yet it is probable that the homeland as thus defined is far too narrow, that it should be extended westward. Certainly in post-Christian times there were Eskimo-like people far to the westward, on the Yamal Peninsula, for example, at the mouth of the Ob, where Chernezov has excavated three of their earth lodges,[18] probably also in northeast Russia, since the kayak and bidarka are reported from that region as late as the sixteenth century.[19] If some antecedent to the Old Bering Sea, Birnirk and Dorset cultures could be discovered on the Arctic coast of western Siberia, it would vastly lessen the gap, both in time and space, between the historic Eskimo cultures and those of the epipalaeolithic peoples of northern Europe to which they bear a considerable resemblance.

In expounding his fertile theory of two culture layers in northern Eurasia and North America, an earlier coastal or ice-hunting layer and a later inland or snowshoe layer, Hatt justly signaled out the Eskimo as belated survivors of the ice-hunting stage who had adapted themselves to life on the seashore and to the hunting of sea mammals. If, as I have attempted to show, this adaptation occurred on the Arctic coast of Siberia, not later than the second millennium B.C. and probably much earlier, than we should look for its inland predecessor in that "Siberian pocket" of which Zolotarev speaks, the Barstinsky Steppes, the upper Irtish, Ob, and Yenesei regions, and the narrow strip of territory extending to Yakutsk. Quite probably it will prove to be but one of many cultures, closely alike, that extended during epipalaeolithic and early neolithic times from the Baltic to eastern Siberia. The snowshoe may have originated on the southern fringe of this zone, perhaps near the Lake Baikal region. At all events, the complex to which it gave rise seems to have contributed very little to the Eskimo cultures until relatively recent times, if we disregard the pressure exerted by its American carriers, the invading Athapaskans, on the Eskimo of eastern Canada. As far as we know today, the snowshoe itself first appears among the Eskimo in the Thule-age mound-dwellings at Wales, Alaska, which may not be older than six or eight centuries.

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[18] Cf Zolotarev, A. The ancient culture of north Asia Amer Anthrop 40: 15. 1938.

[19] Cf MacRitchie, D. Journ. Roy. Anthrop Inst 42: 403–510 1912

I have suggested that pottery, being unknown to the Dorset people, reached Bering Strait after some of the Eskimo had already entered America and wandered eastward. Richthofen[20] has drawn attention to the striking resemblances, particularly in decoration, between pottery found at Krasnojarsk and other places in Siberia, and pottery from the Algonkian or Woodland area in eastern Canada and the northeast United States. Following up this observation, McKern[21] suggests that "a culture closely related and directly parent to the Woodland Pattern, with pottery but without agriculture, originated in Asia, came into America and inland by way of the Yukon and Mackenzie Valleys, had a special development in a locale centering just south of Lake Superior to become what is now classified as the Woodland pattern, and diffused from that center west, south and east to its maximum area limits, which are not as yet well defined."

There are serious objections to this hypothesis. In the first place we have no evidence that any of the pottery found in this section of North America dates back beyond the Christian Era, and in more than one place, e.g., at Lamoka, we have discovered the remains of an earlier people who, like the Newfoundland Beothuk, did not use pottery. Secondly, not a single sherd of pottery is known from the Mackenzie River Basin or the upper reaches of the Yukon; and the pottery on the lower Yukon was probably copied from the Eskimo of the Punuk period. We have every reason to believe that no Athapaskan tribe ever made pottery unless, like the Sarcee, it was in close contact with a pottery-using people. It is true that we have found sherds at a few sites along the southeastern fringe of the Mackenzie Basin—at Isle à la Crosse, Reindeer Lake, and Cree Lake—but only within the range of Cree penetration, and the sherds themselves resemble Woodland pottery from eastern Canada. In view of the vast potteryless gap separating this Woodland area from the Alaskan Eskimo, and the comparative lateness of pottery, apparently, in the Woodland area itself, it would seem more reasonable to believe that the latter acquired the idea of making pottery from the pottery-making peoples bordering them on the south than to connect them with the Krasnojarsk and other Siberian cultures so far removed in space, if not also in time. As long as the highway from Asia to America—that is to say, all Alaska outside the Eskimo area, and the whole of northern and western Canada—yield no sherds, we should cling to the theory that American pottery evolved quite independently of pottery in the Old World.

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[20] RICHTHOFEN, B. FRHR. V. Zur Frage der archaeologischen Beziehungen zwischen Nordamerika und Nordasien. Anthropos 27: 123–151 1932

[21] MCKERN, W. C An hypothesis for the Asiatic origin of the Woodland culture pattern. Amer Antiquity 3: 138–143. 1937. Cf. also FEWKES, V. J. Aboriginal potsherds from Red River, Manitoba. Ibid. 143–155

Beyond the second millennium B.C. we enter a realm of twilight, where ethnology almost ceases to flicker and archeology provides only one or two faint gleams to light our path. From the Gobi Desert in Mongolia, where Nelson[22] discovered a preneolithic microlithic culture of Azilio-Tardenoisian character, and Afontova on the Yenesei, where Von Merhart[23] suspects a microlithic station, we jump to the Amur River, whence other microliths are reported,[24] and from there to Fairbanks, Alaska, where microliths unearthed on the university campus seem to Nelson identical with his Mongolian finds.[25] Can it be that these mark a culture movement from Asia into America, and not merely a culture movement, but a movement of peoples?

Still more recently, and from Fairbanks also, it is reported that a stone spearhead resembling a Yuma type was found embedded in a small mastodon.[26] Now Yuma points are closely related to the Folsom complex, the oldest yet known in America, dating from a period when the camel, the mammoth, the mastodon, and other animals now extinct were still comparatively abundant. Because we have hitherto discovered no trace of this complex outside of the United States and the Canadian prairies, certain writers have suggested that it is a purely North American development. As Nelson[27] points out, however, we must continue to assume that its ancestry lies in the Old World until we find in North America a still older and more primitive industry from which it can be derived. This Yuma-like spearhead at Fairbanks should encourage us to search for the complex farther north and west, right into Asia itself.

The Fairbanks discoveries are intriguing from another standpoint. They appear to disclose one of the stations on man's journey from the Old to the New World, thereby enabling us to map out his route. Many Eskimo have journeyed from Bering Strait round the Arctic coast of Alaska to the Mackenzie River Delta, following a route that was probably open in early postglacial times also. It may, indeed, have been easier at that period than today, for the climate was perhaps milder and the Mackenzie Delta not quite so far north. The discoveries at Fairbanks seem to indicate, however, that some at least of the early migrants passed up the Yukon Valley, crossed to the eastern side of the Rockies (probably over the low divide at the headwaters of the Liard River), and traveled down the eastern foothills of the mountains into the United States. Some of the later migrants may have traveled down the western side of the Rockies also, but in early postglacial times this route was probably blocked by ice.

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[22] BERKEY, C. P., and NELSON, N. C. Geology and prehistoric archaeology of the Gobi Desert. Amer. Mus. Nov., no. 222. 1926.

[23] VON MERHART, GERO. The palaeolithic period in Siberia: Contributions to the prehistory of the Yenisei region. Amer. Anthrop. 25: 45–46. 1923.

[24] Sovietskaya Archaeologiya, no. 1, quoted in Antiquity, Dec. 1937, p. 497.

[25] NELSON, N. C. Notes on cultural relations between Asia and America. Amer. Antiquity 2: 267–272. 1937.

[26] Amer. Antiquity 3: 188. 1937.

[27] NELSON, N. C. Amer. Antiquity 2: 320. 1937.

BOTANY.—*Two new North American species of* Vitis.[1]

J. L. FENNELL, U. S. Plant Introduction Garden, Coconut Grove, Fla. (Communicated by S. F. BLAKE.)

This paper includes descriptions of a new grape of the *aestivalis* series from Florida and of another of the *rotundifolia* group from Mexico. The latter is of especial interest as the first member of the section *Muscadinia* found in the tropics.

Vitis gigas Fennell, sp. nov. Fig. 1

FLORIDA BLUE GRAPE

Rami saepius glandulari-spinulosi, innovationibus dense albido- vel ferrugineo-tomentosis; folia magna saepius 3–5-lobata inaequilateralia, lobis acutis vel acuminatis; thyrsi fructiferi plerumque ramosi conici; baccae nigrae glaucae 10–14 mm diam ; semen ca 6 mm longum 4 mm latum pallide olivaceum, raphi canalem apice seminis paene explente, rostro et chalaza obscure aurantiacis.

Series Aestivales Vigorous high-climbing and heavy-foliaged vine with large leaves and strong heavy canes; internodes medium to long, mostly beset with few to many glandular prickles on strong growths; young wood green or reddish, mostly with some pruinose bloom near nodes, but this often obscured by the rusty wool, canes terete, finely striate, mostly retaining gray tomentum and black prickles into winter, then of a dark buckeye color; diaphragm of full-sized dry canes typically about 3 mm thick; tendrils intermittent, strong, often trifid, brown-woolly; growing tips and young leaves covered with a dense white or cream or even rusty-colored feltlike tomentum which mostly becomes rusty-floccose a foot or so back from tip. Petioles slender, medium to long, usually 6–8 cm, often retaining loose wool, round or sometimes shallowly grooved above; leaves large, commonly 6–7 inches long from tip of apex to tip of basal lobe, by 5–6 inches broad, often larger, rusty, tan or gray-tomentose beneath; generally ovate, mostly sharp-shouldered, but often 3- or sometimes 5-lobed, and then often unequilateral; margin irregularly, sometimes deeply sinuate-toothed with most of the principal veins ending in a slender cusplike point; basal sinus broadly to narrowly U-shaped; apex of leaf acute and mostly long-tapering; shoulder points mostly acute and often long-acuminate, occasionally

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[1] Received September 15, 1939

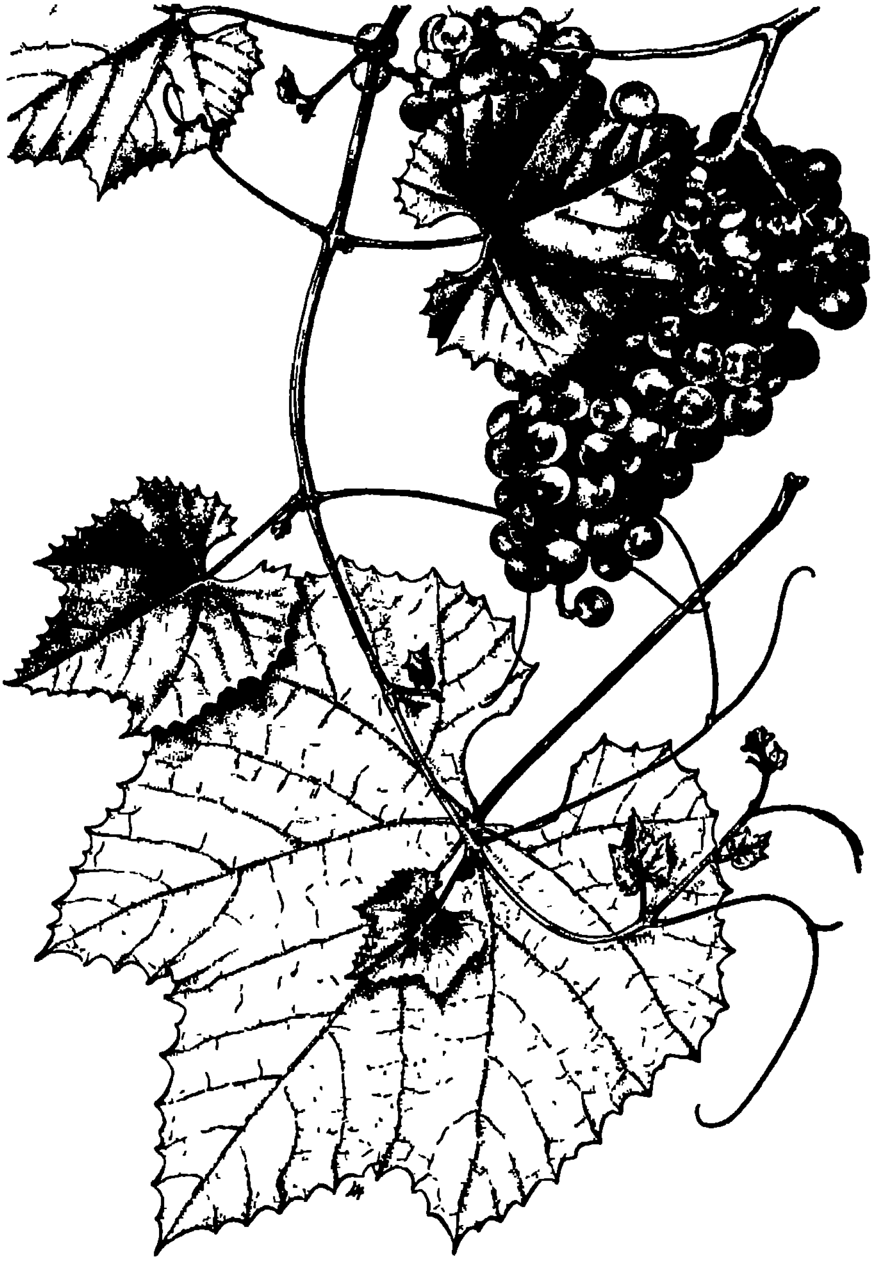

Fig 1.—*Vitis gigas*, ×½

rounded and then mostly short-acuminate-tipped. Inflorescences 11–19 cm long, conical to broadly so, mostly well compounded; peduncle slender and moderately long, often with false tendril; pedicel slender and long, giving cluster a somewhat lax appearance, at insertion of berry green and but little warty. Berry spherical to slightly oblate, 10–14 mm, black, with medium to heavy bloom, mostly blue in appearance when ripe; pulp greenish. Seeds plump, 6 mm long by 4 mm broad, pale olive or tan in color due to the tan-colored scurf which holds tightly to the coffee-colored testa; chalaza round to ovate, little sunken, and like the beak, of a dull orange color; raphe and chalaza surrounded by a tiny groove on outer face, ventral depressions pale tan in color, shallow, curving away from raphe toward top.

FLORIDA: Sebastian River, near Roseland, Brevard County, July 20, 1938, *J. L. Fennell* 713 (type nos 52252–52253, National Arboretum Herbarium).

From present knowledge *Vitis gigas* apparently has a very limited range, though in colonies where found it constitutes the typical and abundant representative of the Aestivalian series In a few cases it takes close observation to distinguish by the foliage alone the Florida blue grape from some of the natural hybrids of *V. shuttleworthii* or of *V. simpsoni* (*V. cinerea floridana*). However, the spinulose pubescence of the internodes, the blue bloom of the shoots and fruit, the much larger leaves, the green pulp of the berries, and the different seeds are distinctive.

In a few respects, such as shape of leaf, *Vitis gigas* is suggestive of some of the midway forms of *V aestivalis* and *V. argentifolia* as seen in Virginia or Kentucky. The great vigor and rampant growth of the Florida species, however, as well as the different soil and climatic associations and its botanical peculiarities, set the Florida blue grape apart as a distinct kind

The species is characteristically found forming heavy canopies of foliage over trees along the dry shelly banks of brackish waterways and lagoons Together with the rampant *Dalbergia ecastaphyllum*, it often forms almost smothering mantles of growth that extend from the water's edge to the tops of the highest jungle trees. I have often seen half-grown boys clamber up over these strong tangles of vines from the water to the very topmost branches of the trees 50 feet or so above the river

Vitis gigas is found mostly in sweet soil having a high shell content

Vitis popenoei Fennell, sp. nov Fig. 2

"TOTOLOCHE" GRAPE; SOUTH MEXICAN MUSCADINE GRAPE

Cortex adhaerens lenticellatus non fissilis; medulla nodis non interrupta; cirrhi interrupti simplices; folia serrata glabrata longiora quam latiora longe attenuata, in petiolis pubescentibus supra sulcatis; semen reticulatum in facie exteriore e rostro ad apicem sulcatum.

Subgenus *Muscadinia*. Slender vine with tight, lenticellate, nonshredding bark; pith of canes continuous; matured first year canes olive-brown in color, lucid, sometimes finely puberulent especially near nodes, often somewhat swollen above nodes; tendrils intermittent, simple, glabrous except near base; young growth somewhat angled or squared. Mature leaves small to medium, usually cordate-ovate with slenderly acuminate apex, not broader than long (from insertion of petiole to apex), thin, rugose, lucid, glabrous on both sides except for some pubescence on the nerves beneath, moderately to coarsely serrate and often finely ciliate, the sinus narrowly to broadly V-shaped, the under surface occasionally somewhat reddish, the shoulder points sometimes prominent; lateral veins (not including the subbasal veins) 3 or 4 pairs; petioles slender, moderately long, grooved above, finely and closely puberulent. Fruiting panicle not seen (said to be of small to medium size); berry not seen (said to be about one-half inch in diameter, maroon red to purple in color; skin thick; pulp green; ripe fruit has musky aroma [Popenoe's notes]). Seeds mostly about 5.5–6 mm long, about 4 mm broad, ovoid to nearly oblong, often unequally developed; beak short; groove extending from beak to top of seed on outer face; chalaza elliptical to sometimes nearly round; raphe evident only on inner face of seed and then as narrow thread; color of seed very dark and surface when dry reticulate-wrinkled.

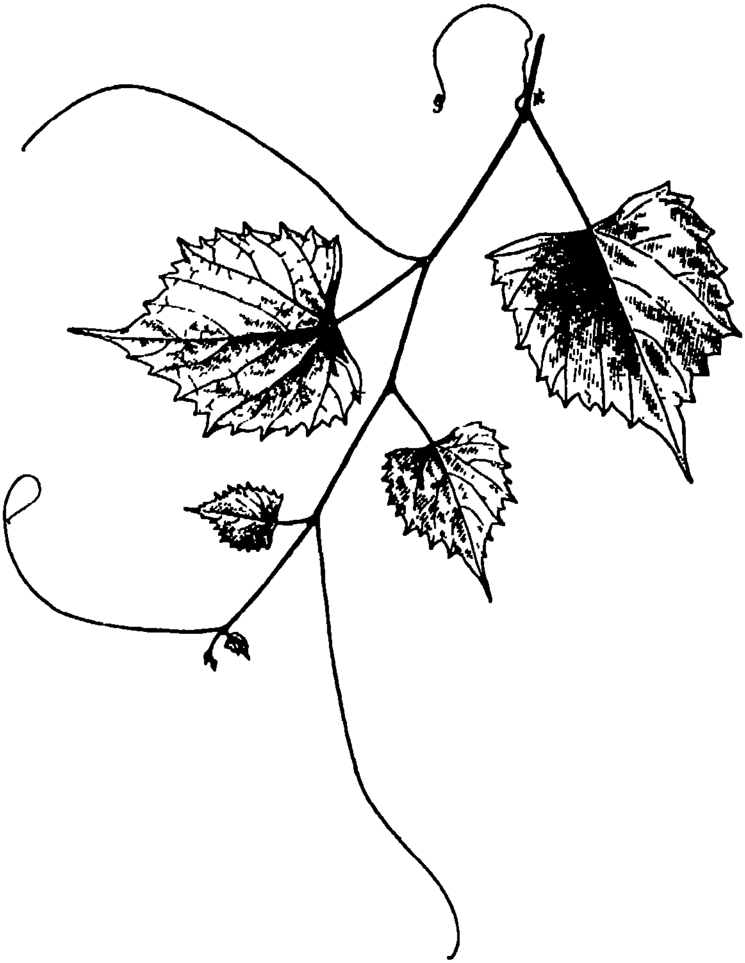

Fig. 2.—*Vitis popenoei*, ×½.

MEXICO: Grown at Coconut Grove, Fla., from seed collected by Wilson Popenoe (P.I. 119001) at Puerto Mexico, Isthmus of Tehuantepec, Veracruz, Mexico. Type no. 56266, National Arboretum Herbarium, collected July 5, 1939, by J. L. Fennell (no. 1008).

In general appearance *Vitis popenoei* is somewhat more suggestive of *V. rotundifolia* than of *V. munsoniana* owing to the mostly smaller-toothed leaf margins and the thin, rugose leaf texture. It is at once distinguished from either of these species, however, by the relatively longer leaves and by the slenderly prolonged leaf apex. In this respect the foliage is somewhat suggestive of that found on certain forms of *V. cordifolia*. Average leaves of both *V. rotundifolia* and *V. munsoniana* measure broader than long (from insertion of petiole to apex) in distinct contrast with those of *V. popenoei*, which are mostly not broader than long.

In addition to its botanical differences *V. popenoei* occupies a distinct climate and a range several hundred miles farther south than that occupied by either of the other two known species of *Muscadinia*. It is the first and only muscadine grape yet known to occur naturally within the tropics. A study of its genetic relationship as regards the other muscadine and Euvitis species might bring to light certain characters of horticultural or botanical interest.

BOTANY.—*Two new species of* Muhlenbergia.[1] CHARLOTTE O. GOODDING, Rocky Mountain Herbarium, Laramie, Wyo. (Communicated by JASON R. SWALLEN.)

Recent study of the genus *Muhlenbergia* has revealed the presence of two new species, both of which occur in the canyons of southern Arizona.

Muhlenbergia xerophila C. O. Goodding, sp. nov.

Perennis; culmi dense caespitosi, glabri vel scaberuli, 45–90 cm alti; ligula obtusa, 1.5–3 mm longa; laminae involutae, 15–50 cm longae, 1–1.5 mm latae; panicula pallida, 15–35 cm longa; glumae 2–3 mm longae, acutae vel acuminatae, scabrae ad apex; lemma 4 mm longum, scabrum; callum hirsutum; arista 18–25 mm longa.

Plants perennial; culms densely caespitose, glabrous to very slightly scabrous especially below the nodes, 45–90 cm tall or sometimes more; sheaths rounded, very slightly scaberulous; ligule membranaceous, 2–4 mm long, obtuse; blades involute, 1–1.5 mm wide, 15–50 cm long; panicle open, 15–35 cm long about 4–5 cm wide, pale, the branches up to 7 cm long, filiform, flexuous; spikelets about 4 mm long; glumes equal to slightly unequal 2–2.5 or even 3 mm long, 1-nerved, acute to acuminate, the apex scabrous to very short pubescent; lemma about 4 mm long, scabrous above with short tufts of hairs on the callus, 3-nerved, the midnerve extending into a slender awn 10–35 mm long.

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[1] Contributions from the Department of Botany and the Rocky Mountain Herbarium of the University of Wyoming, Laramie, Wyo., no. 175. Received September 25, 1939.

This species differs from *M. setifolia* in having acute to acuminate glumes, longer blades, which are not curled below, and a longer panicle; from *M. rigida* in having as a rule a longer and narrower panicle, a shorter, broadly rounded ligule, and longer acute to acuminate glumes, scabrous at the tip; and from *M dubia* and *M. metcalfei* in having a wider panicle, a shorter ligule, which is rounded instead of somewhat lacerated above, acute glumes, scabrous at the apex, and long-awned lemmas.

TYPE: *L N. Goodding* M 262, collected in Sycamore Canyon, Ariz., September 22, 1937. The type specimen is deposited in the Soil Conservation Service Herbarium at Tucson, Ariz, with duplicate types in the Rocky Mountain Herbarium, Laramie, Wyo., and in the U. S. National Herbarium.

SPECIMENS REFERRED TO THIS SPECIES: *Silveus* 3477, collected in Sycamore Canyon, Ariz, September 25, 1938; *Silveus* 3489, collected in Box Canyon, Ariz, September 25, 1938; *Goodding* A 9493, collected in Forest Cabin Canyon, Baboquivari Mountains, Ariz, September 24, 1938; *Hardies and Proctor* M 152, collected in Sycamore Canyon, Ariz., November 24, 1936

Muhlenbergia dubioides C. O. Goodding, sp. nov.

Perennis, culmi dense caespitosi, striati; ligula truncata, 1–2 mm longa; laminae involutae, 15–50 cm longae, 1–2 mm latae; panicula pallida, angusta, 15–35 cm longae, 2–4 cm lata; glumae 2–3 mm longae, acute vel erosae, scabrae ad apex, lemma 3.5–4 mm longum, scabrum; callum hirsutum; arista 3–10 mm longa.

Plants perennial; culms densely tufted, more or less striate, 50–100 cm tall; sheaths rounded; ligule firm to membranaceous, truncate, 1–2 mm long; blades elongate, involute, 15–50 cm long, 1–2 mm wide, scabrous above and glabrous to scaberulous below; panicle 15–35 cm long, 2–4 cm wide, pale, the branches appressed, the lower branches 2–8 cm long, rather densely flowered; pedicels slender, scabrous; spikelets about 4 mm long; glumes membranaceous, 2–3 mm long, subequal, faintly nerved, acute, more or less erose at apex, scaberulous above; lemma 3.5–4 mm long, 3-nerved, scaberulous above and often almost to the base, the callus with tufts of hairs 1–1 5 mm long, the midnerve extending into a rather straight, scabrous awn 3–10 mm long

This species resembles *M. dubia* in the appearance of the panicle but differs in having a shorter truncate ligule, acute glumes, and a hairy callus. From *M. xerophila* this species may be separated by its narrow contracted panicle, short-awned lemmas, and more truncate ligule.

TYPE· *W A. Silveus* 3490, collected in Box Canyon, Ariz., September 25, 1936 The type specimen is deposited in the Soil Conservation Service Herbarium in Tucson, Ariz

Also referred to this species is *E. W. Hardies* and *Ed Morris* M 155, collected in Bear Canyon, Santa Catalina Mountains, Ariz, November 28, 1936.

ZOOLOGY.—*Actiniaria from Alaska and Arctic waters.*[1] OSKAR CARLGREN, Lund, Sweden. (Communicated by WALDO L. SCHMITT.)

Capt. F. E. Lewis, of Balboa, Calif., owner and commander of the M.S. *Stranger*, with the assistance of W. Williams as collector, in the course of his 1937 expedition to the coasts of Alaska and north of Bering Sound obtained an extensive series of marine invertebrates. Included in the material were five species of actinians, which were submitted to me some months ago by the U. S. National Museum for determination. Two of the species seem to be new to science. One of them, *Epiactis polaris*, n. sp., is especially interesting, as it develops its embryos in a circular brood chamber situated in the uppermost part of the body—a type of brood chamber not previously known from Arctic waters but described by me from southern oceans. Because there is a close relationship between the Actiniaria in Bering Sea and the waters of north Japan, I have added here a species of *Edwardsia* dredged in the Sea of Japan in a depth of 2,300 meters, showing that a species of this genus, most of the members of which live in very shallow water, can occur in so great a depth. Finally, I avail myself of the opportunity to comment briefly on some Actiniaria described by Uchida from the coast of Japan.

Family EDWARDSIIDAE

Edwardsia arctica Carlgren Fig. 1

Locality —Sea of Japan, 41° 38 5′ N , 132° 08′ E , 2,300 m , mud and rubble, temperature at the bottom +0.18°, K. Derjugin, 15.10.1932, 2 specimens

Discussion —The specimens were small, sterile, and very badly preserved. The body was so strongly contracted that several tentacles were squeezed out through the aboral part of the body, the invaginated part containing a great deal of detritus, rendering the examination of the animals very difficult. I think, however, that they may be referred to ***Edwardsia arctica*** There is nothing about the temperature in which the specimens were taken to refute such a supposition, as it was a little over zero. As a rule, the nemathybomes seemed to contain no nematocysts. By maceration, however, I found some 46–48 by about 4.5μ in size. The nematocysts of the tentacles were 19–24 by 2 5μ, the spirocysts about 12 by 1 5–27 by 5μ. There are probably 16 tentacles. The appearance of the retractors (fig. 1, *a*) and parietal muscles (fig. 1, *b*) of the perfect mesenteries and the distribution of the latter on the column seem to agree fairly well with those in *arctica* (Carlgren, Actiniaria, *The Danish Ingolf Expedition* **9**, 1, fig 33–38, p. 41 1921).

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[1] Received July 26, 1939

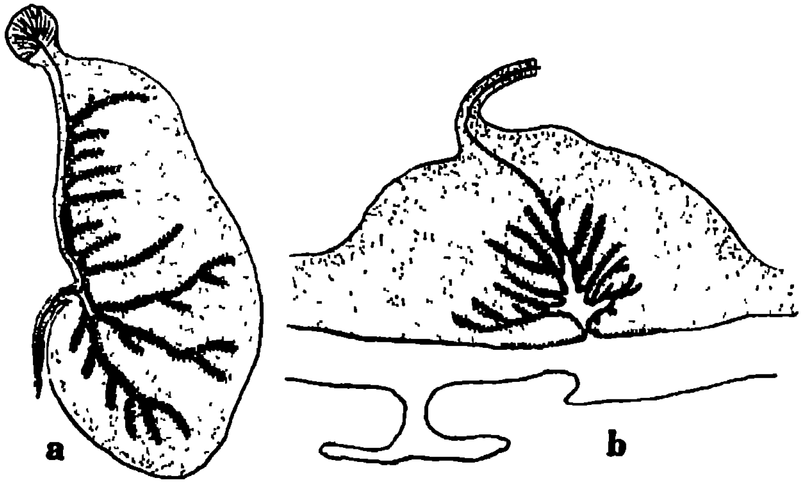

Fig 1.—*Edwardsia arctica* Carlgren: *a*, Transverse section of retractor; *b*, transverse section of parietal muscle of perfect mesentery

Family HALCAMPOIDIDAE

Halcampoides purpurea (Shed.)

Locality.—Punuk Island, Bering Sea, 15 fathoms, fine sand, mud, rocks, 15.1.1937, M.S. *Stranger*, W. Williams, several specimens.

Peachia parasitica (Agassiz)

Locality.—Nash Harbor, Nunivak Island, Alaska, rocky gravel, fine sand mud, 20.7.1937, M.S. *Stranger*, W. Williams, 1 specimen.

Discussion.—The fairly strongly contracted, sterile specimen, the length of which was 1.8 cm, the breadth 1.3 cm, had 10 tentacles and 20 mesenteries arranged typically. The conchula was provided with three lobes, one median and cylindrical and two more conical. The nematocysts of the column were 22–29 by 3.5–5μ, often a little curved; those of the tentacles 26–36 by 3.5–5μ, numerous; those of the actinopharynx partly 27–36 by 4.5–5μ, partly 14–17 by 2.5μ; those of the filaments partly 27–35 by 3.5–4μ, partly 36.5–49 by 5–5.5μ, microbasic p-(penicilli-like) mastigophors; the spirocysts up to about 26 by 2.5μ. The color agreed very much with that of *Bicidiopsis tubicola* Verrill. It was pale salmon in alcohol, and the tentacles were provided with four brown cross bands.

Remarks.—*Peachia* (*Siphonactinia*) *parasitica* Agassiz, *Bicidiopsis tubicola* Verrill, *Bicidiopsis arctica* Verrill, and probably *Peachia quinquepunctata* McMurray are, I think, different development stages of one and the same species—a form that reaches a considerable size before it gives up its parasitic mode of life and develops the eight imperfect mesenteries. The different appearance of the conchula is of no great importance, as in *Peachia* the number of papillae increases with the age of the specimen. Verrill (*Report Canadian Arctic Expedition*, pt. G, p. 125, 1922), proposed the genus *Bicidiopsis* for *Siphonactinia* having 20 mesenteries and a mesogloeal sphincter. This latter statement is certainly incorrect—there was no sphincter in the present specimen. He mentions also that *Bicidiopsis* sometimes had 18 tentacles. If really so, the specimens may have been very abnormal or probably belonged to *Eloactis* or *Haloclava*.

Family BUNODACTIIDAE

Epiactis lewisi, n. sp. Fig. 2

Description.—Body cylindrical, smooth. Fairly close to the sphincter a circular deep invagination forming a brood chamber in the female and containing very large embryos very rich in yolk. Sphincter endodermal, circumscript. Tentacles conical, rather long, probably 24. Longitudinal muscles of the tentacles and radial muscles of the oral disk ectodermal. Actinopharynx longitudinally sulcated. Two well-developed siphonoglyphs. Twelve (6+6) mesenteries, all well developed, perfect, and fertile. Two pairs of directives. Not more mesenteries at the base than at the margin. Retractors of all mesenteries strong, fairly concentrated, those of the mesenteries of the second order, however, weaker than those of the first. Parietobasilar muscles very well developed on a strong offshoot of the mesogloea. Ova very large and rich in yolk. Nematocysts of the column 23.5–26 by 2.5μ; basitrichs, those of the tentacles 29–31 by about 3μ, those of the actinopharynx partly 36–38 by about 4μ, few, partly 26–30 by about 4.5μ, the latter microbasic p-mastigophors, those of the filaments partly 30–34 by 4.5μ, microbasic p-mastigophors, partly 31–38 by about 3μ, partly 14–18 by 2–2.5μ, the latter probably basitrichs.

I have figured the sphincter (fig. 2, *a*) and two mesenteries, one of the first order and one of the second at the level of the lowermost part of the actinopharynx (fig. 2, *c*). Because I did not wish to mutilate the single specimen I had, I have examined closely only two pairs of the mesenteries of the second order. As these pairs were perfect and fertile, there is no reason to suppose that the other mesenteries of the second order should be otherwise constituted.

The brood chamber was formed by a deep circular invagination fairly close to the sphincter. In the bottom of this invagination each embryo lay in a special pocket (fig. 2, *b*). Because of their great size (0.2 by 0.25 cm in diameter), they were rather few in number. The embryos were probably in the gastrula stage. Owing to their poor preservation, I can not decide whether they were ciliated.

Color unknown.

Size in preserved state: Length 2 cm, breadth 1–1.1 cm.

Locality—68° 30′ N., 169° 20′ W., about 30 fathoms, fine gray mud, 7.7.1937, M.S. *Stranger*, F. E. Lewis, 1 specimen.

Remarks.—The species is closely related to *Epiactis* (*Pseudophellia*) *arctica* (Verrill) and *E. marsupialis* Carlgren, both of which, however, had the brood chamber in the lowest part of the body and more mesenteries at the base.

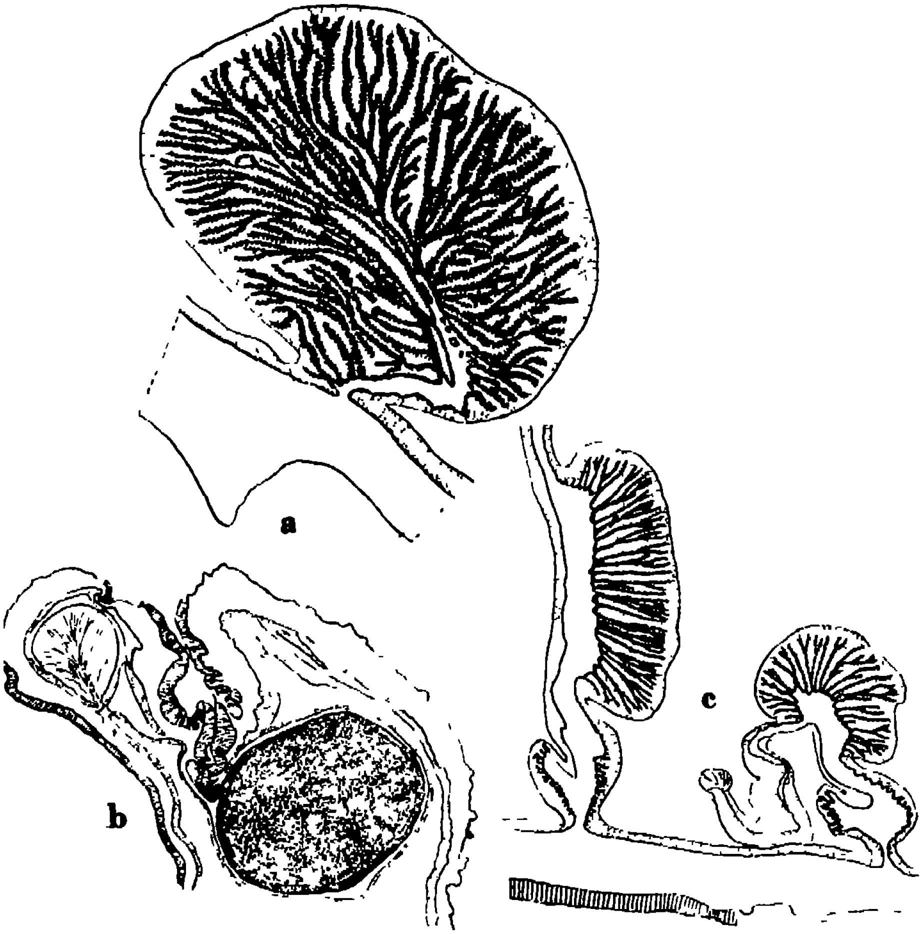

Fig. 2.—*Epiactis lewisi*, n. sp. *a*, Transverse section of sphincter; *b*, longitudinal section of uppermost part of body, showing sphincter and brood chamber with embryo; *c*, section of one mesentery each of first and second orders at level of lowermost part of actinopharynx.

Cribrinopsis williamsi, n. sp. Figs. 3, 4

Description.—Pedal disk broad, diminishing in breadth upward. Column provided with verrucae in its upper part. Margin with perforated, fairly well developed pseudosphaerules. Fossa deep. Sphincter strong, circumscript, with a rather short main lamella. Tentacles about 48, almost as long as the body, conical, and, at least in somewhat contracted state, almost papillous. Longitudinal muscles of tentacles ectomesogloeal, strong, radial muscles of oral disk mesoectodermal. Two broad siphonoglyphs with well-developed aboral prolongations. Mesenteries more numerous than the tentacles, at the base about 72, two pairs of directives, about 24 pairs perfect. All mesenteries were sterile. Retractors of the mesenteries recalling those of *Epiactis polaris* but weaker, parietobasilar muscles as in this species. Nematocysts of the column 17–19 by 2–2.5μ, those of the pseudosphaerules 17–22 by 2–2.5μ, those of the tentacles 30–38 by 2.5–3μ, common, those of the actinopharynx partly 34–41 by 4–5μ, partly 27.5–31 by 2.5–3μ, partly 14–19 by about 2.5μ, those of the filaments 24–29 by 4.5–5μ, microbasic p-mastigophors, spirocysts of tentacles about 19 by 2–38 by 4μ

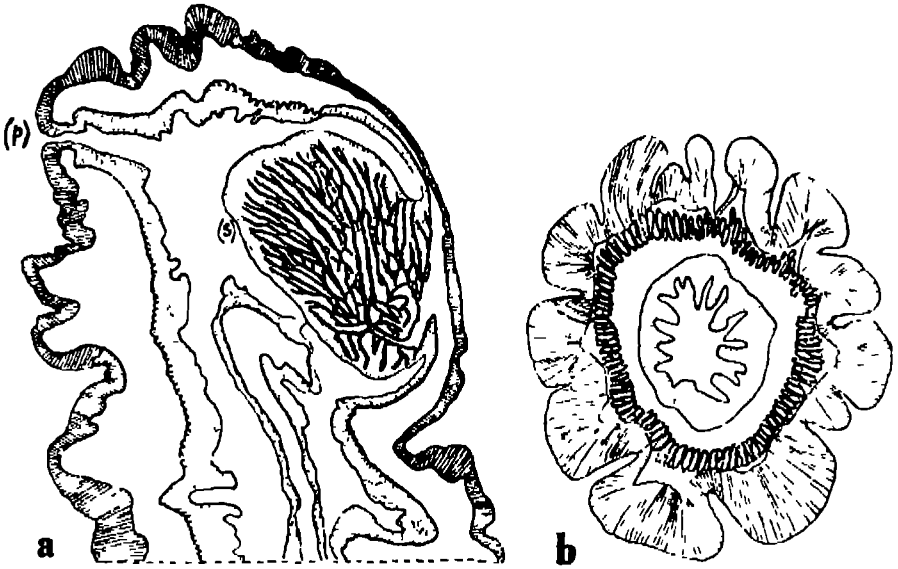

Fig 3.—*Cribrinopsis williamsi*, n sp *a*, Section of uppermost part of column, showing sphincter (*s*) and one perforated pseudosphaerule (*p*), *b*, cross section of tentacle

I have reproduced a section of the uppermost part of the column in Fig 3, *a*, showing the sphincter (*s*) and one perforated pseudosphaerule (*p*) On the left side there is an invagination in the endoderm and mesogloea, indicating the border of a verruca The pseudosphaerules do not seem to contain more

Fig 4.—*Cribrinopsis williamsi*, n sp. An individual tentacle.

nematocysts than other parts of the column; it was difficult, however, to get good maceration preparations of them. Fig. 4 shows the exterior of a tentacle, Fig. 3, *b* a cross section. The main lamella of the sphincter in other places was sometimes a little stronger, the folds more numerous.

Color unknown.

Size: Breadth of the pedal disk 1 3 cm, at the margin 0.9 cm, height of the body, 1 3 cm, length of the inner tentacles 1 2 cm, of the outer ones 0.5 cm.

Locality.—Humpback Bay, Alaska, 56° 11′ N., 131° 54′ W., 15 fathoms, near shore, 19.8.1937, M.S. *Stranger*, W. Williams, 1 specimen

Remarks.—As the specimen was sterile, the placing of the species in the genus *Cribrinopsis* is somewhat dubious, but there is no objection to referring the species to this genus except for the presence of pseudosphaerules, which I did not note in my description of *Cribrinopsis similis* (l.c., 1921, p. 156), the only known species. But, as in the genus *Bunodactis*, in which pseudosphaerules sometimes occur, it is not surprising that they may be present in *Cribrinopsis*. In fact, at first I was inclined to identify the specimen with *similis*, but, as the nematocysts were smaller, the tentacles considerably longer, thinner, and more papillose, and pseudosphaerules were present here, I think it is better to consider the present form as a distinct species.

Family ACTINOSTOLIDAE

Stomphia coccinea (O F. Müller)

Localities.—Off Codbora Bay, Victoria, British Columbia, 10 fathoms, hard bottom, 9.8 1937, M S. *Stranger*, W. Williams, 2 specimens; Humpback Bay, Alaska, 56° 11′ N , 131° 54′ W., 15 fathoms, near shore, 19.8.1937, M.S *Stranger*, W. Williams, 1 specimen; Cleveland Passage, Alaska, 57° 33′ N., 133° 30′ W., 12 fathoms, rocky, 16 8.1937, M.S *Stranger*, W. Williams, 1 specimen; Teller, Alaska, 65° 16′ N , 166° 25′ W , 5 fathoms, mud, some rocks, 11.7.1937, M.S. *Stranger*, W Williams, 1 specimen; 68° 30′ N , 169° 20′ W., about 30 fathoms, fine gray mud, 7.7.1937, M.S. *Stranger*, F. E Lewis, 1 specimen.

Most of the specimens were small. As to the determination of the last species I am somewhat uncertain. It is possible that it is a young *Actinostola*.

COMMENTS ON CERTAIN SPECIES OF JAPANESE ACTINIARIA

Uchida (Sci. Rep. Tohuko Imp. Univ. (4), Biol., **13**: 293 1938) refers *Bunodactis stella* to *Anthopleura*, owing to the fact that the figure of this species given by Verrill, 1864, indicates the presence of marginal sphaerules. I have examined many specimens of *stella* from different localities and find no traces of such formations. Verrill also refers the species to *Bunodactis*. Unfortunately, Uchida gives no notes about the nematocysts. The marginal sphaerules proper always are provided with atrichous nematocysts. If atrichs are absent in Uchida's *A. stella*, this species is probably identical with Verrill's form; if the contrary, not. Uchida (l.c., p. 309) set up *Epiactis ritteri*, described by Torrey from Alaska, as synonymous with *Epiactis prolifera* Verrill. This is, I think, not correct. The species I called *Cnidopus ritteri* (Torrey), also taken on the coast of Alaska, is very different from *prolifera* and, as far as I can see, is identical with Torrey's species; the nematocyst batteries at the base of *Cnidopus* probably consist of atrichs. It is questionable if Uchida's *Eloactis mazeli* (l.c., p. 288) is identical with the European species. Some other species described by Uchida are not referred to the right genus. *Andwakia hozawai* is probably not *Andwakia*, as it seems to lack tenaculi proper. *Milne-Edwardsia akkeshi* (Annot. Zool. Japon. **13**: 571. 1932) is certainly not *Milne-Edwardsia* but belongs to a new genus, if it is not identical with *Drillactis*, the anatomy of which is unknown. *Phellia decora* (Annot. Zool. Japon. **17**: 623. 1938) is not a *Phellia* but a *Telmatactis* (or possibly another genus previously described, see Stephenson, *The British sea anemones*, 1935, and Carlgren, Vet.-Akad. Handl. Stockholm (3) **17**: 67–68. 1938). Moreover, it raises the question as to whether the synonyms enumerated by Uchida of *decora* are correct.

ZOOLOGY.—*Notes on the morphology of* Macrostomum ruebushi *var.* schmitti.[1]

WAYLAND J. HAYES, JR., University of Virginia, and FREDERICK F. FERGUSON, College of William and Mary. (Communicated by WALDO L. SCHMITT.)

In October and November 1938, while investigating a pond and its spring source situated beside Charlotte Pike, Nashville, Tenn., one quarter of a mile west of the intersection of Old Hickory Boulevard with the Pike, we discovered what appears to be a new variety of a turbellarian worm, *Macrostomum ruebushi* var. **schmitti**. In this, the type locality, the variety, of which we obtained many specimens and studied about 50 mature individuals, was associated with *Stenostomum virginianum*, *S. tenuicaudatum*, *Dalyellia rossi* var. *tennesseensis*, *Gyratrix hermaphroditus*, and unidentified species of *Provortex* and *Geocentrophora*. The new variety is named in honor of Dr. Waldo L. Schmitt, curator of marine invertebrates, U. S. National Museum, in gratitude for his kind assistance in our work upon Turbellaria. The cotypes are deposited in the U. S. National Museum as no. 20529.

Description.[2]—Sides of the dorsoventrally compressed body subparallel for the greater part of the length of the animal, without lateral indentations in the cephalic region, with slight gradual depressions marking off the spatulate tail; body colorless except for dark eyes and enteric inclusions;

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[1] Received September 6, 1939.

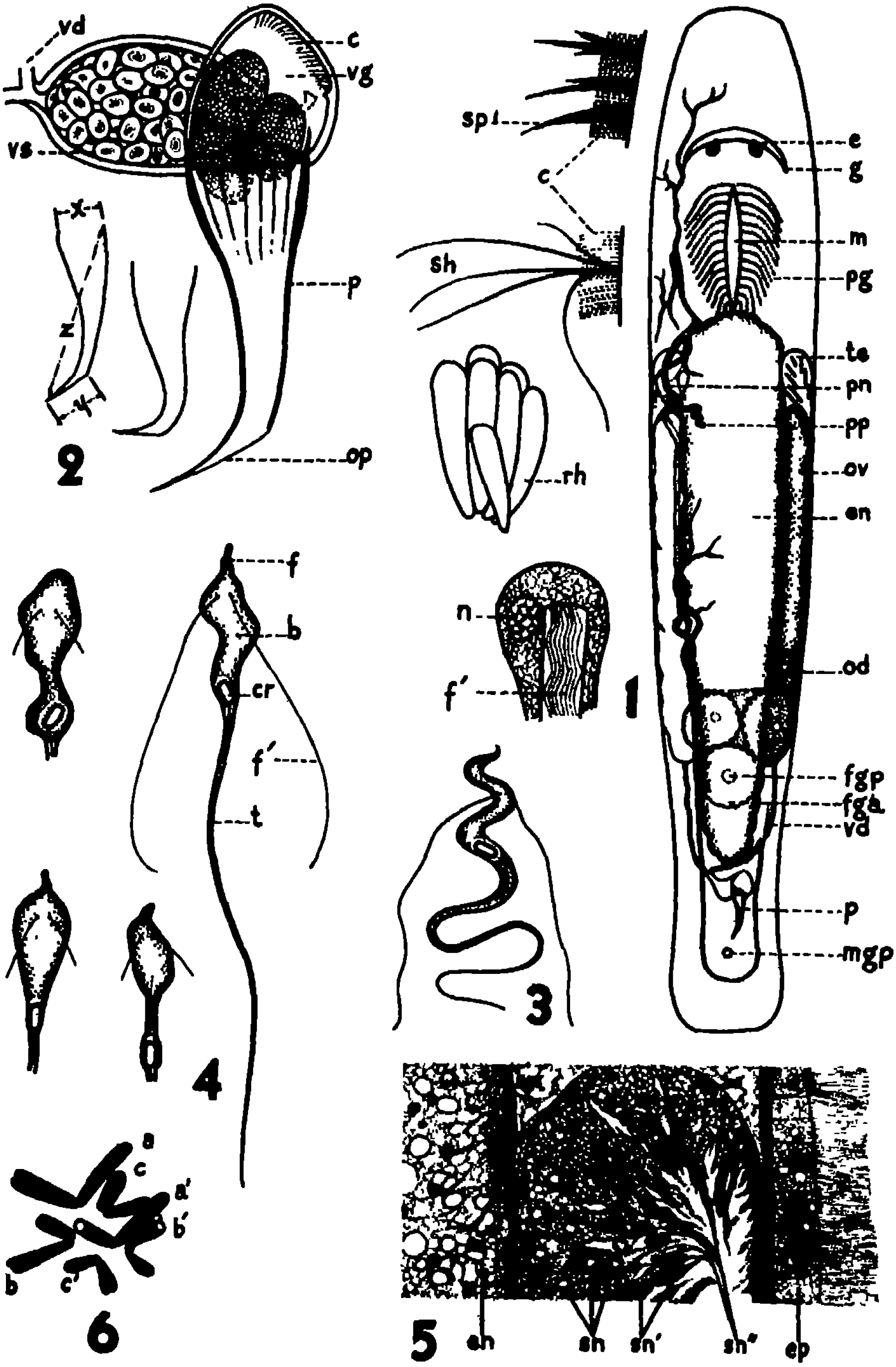
[2] The name of this variety was first published in the program of the Seventeenth Annual Meeting of the Virginia Academy of Sciences at Danville, Va., p. 18, May 6, 1939, without description. The characters of the variety were discussed by Mr. Hayes in the paper that he delivered at that time before the Academy. The present account, however, constitutes the first publication of the variety.

total length 1 to 1.7 mm. Epidermis of flattened, usually pentagonal cells bearing an even coat of cilia 10 to 11μ long. Rhabdites, in groups of 1 to 12, distributed over the entire epidermis but most abundantly at the extremities; weak Rhabditenstrassen present anteriorly, Stäbchen abundant, radially arranged about the female gonopore; rhabdites 9.8 to 14μ long, 1.4 to 2.1μ wide; Stäbchen smaller. With groups of sensory hairs 30 to 50μ long and lacking basal spines distributed among the cilia laterally and posteriorly, the lateral hairs stouter than the posterior ones; with semirigid spines 25μ long restricted to the anterior cephalic margin. Paired cerebral ganglia joined by a broad commissure to form a crescent-shaped "brain" located equidistant between the dorsal and ventral sides of the body. Paired eyes approximately 17μ in greatest diameter immediately behind and dorsal to the "brain." Mouth bounded by ciliated lips located ventrally 145 to 190μ from anterior end. Pharyngeal glands directed laterally and then posteriorly, often exhibiting in fixed and stained material large eosinophilic vacuoles bounded by basophilic granules. Enteron saclike, considerably lobed, ciliated, extending dorsally above female gonopore almost to union of vasa deferentia. Excretory system of two laterodorsal main-stems extending almost from one end of the body to the other and connected posterior to the male gonopore by a commissure, main-stems with paired lateral branches including paired end-stems, which, at a level 100 or 130μ behind the anterior end of the enteron, pass mesially and dorsally over the enteron and, coiling, end in paired dorsal openings. Flame cells with flagella about 10μ long. Testes obovate, smooth, located lateroventral and only slightly posterior to anterior end of enteron. Vas deferens extending caudally from each testis to posterior end of enteron and there uniting with its counterpart in entering the vesicula seminalis. False vesicula seminalis not observed. Vesicula seminalis muscular, contractile, thin walled when filled with sperm, thick walled when empty. Entrance from vesicula seminalis to vesicula granulorum guarded by a sphincter. Vesicula granulorum with the proximal portion ciliated, distal portion and the stilette usually filled with granular ma-

Figs. 1-6.—*Macrostomum ruebushi* var. *schmitti*. 1, Dorsal view of gross anatomy, detail of epidermal spines, detail of sensory hairs, detail of rhabdites, and detail of flame cell; 2, male sex apparatus and two views of penis stilette under varying pressure beneath the cover glass (scheme of measurement: x = base, y = opening, z = total length); 3, normal, living sperm; 4, living sperm swollen by contact with water and three views of the body of the same sperm in different stages of movement; 5, longitudinal section through the testis, showing the condensation of the nucleus during the maturation of the spermatid; 6, somatic metaphase chromosome plate.

ABBREVIATIONS USED

b	body	*ov*	ovary
c	cilia	*p*	penis stilette
cr	chromatin granule	*pg*	pharyngeal glands
e	eye	*pn*	protonephridium
en	enteron	*pp*	excretory pore
ep	epidermis	*rh*	rhabdite
f	feeler	*sh*	sensory hairs
fga	female genital atrium	*sn*, *sn′*, *sn″*	nucleus in stages of condensation to form chromatin granule
fgp	female genital pore		
fl	flagellum	*sp*	spine
g	ganglion of brain	*t*	tail
m	mouth	*te*	testis
mgp	male gonopore	*vd*	vas deferens
n	nucleus	*vg*	vesicula granulorum
od	oviduct	*vs*	vesicula seminalis
op	opening		



Figs 1–6.—(See opposite page for explanation.)

terial organized into bundles. Penis stilette a conical tube housed in a muscular tunic; the cuticular walls thickest near the base and there hardly a micron thick, capable of slight change of shape under pressure; the base widened, highly crenate, the apex flexed at an angle less than 90° and with the opening lacking a distal lip or flange, terminal on the convexity of the curve; average measurement[3] of base 18.5μ, of opening 14.1μ, of total length 62.9μ. Male gonopore approximately 65μ from the posterior end of body. Mature sperm cell highly mobile, 35 to 40μ long, 3.5 to 4μ wide, composed of body and of tail provided with axial filament, body with two flagella about 20μ long extending lateroposteriorly from the anterior portion, posterior portion of body with a single, oblong, in life extremely hyaline granule about 2μ long, which after proper fixation always stains with Heidenhein's hematoxylin, Gentian violet, and Feulgen reaction, none of which treatments stain the remainder of the cell. Female genital system typical for the genus. Ovary about one-fourth as long as the body. Egg grayish. Female gonopore about 200μ from the posterior end of the body. Chromosome number, N = 3, 2N = 6. Chromosomes, as fixed in Allen's B-15 fixative, with one large pair about 3μ long and the centromere submedian, one medium-sized pair with the centromere displaced slightly toward one end, and one small pair with submedian centromere.

Differential diagnosis.—Penis stillette not distally enlarged, the proximal end truncated at right angles to the shaft and crenated, the distal end obliquely truncated and with terminal opening not provided with a distal lip, the shaft with a single flexure of less than 90° near the distal end and with a total length averaging 63μ; pharyngeal glands without striking pigmentation; sensory hairs 50μ or less in length; enteron extending well beyond the female genital atrium; mature sperm 35 to 40μ long and characterized by two flagella and by a single, nuclear-staining granule located in the posterior part of the sperm body.

Remarks.—Macrostomum ruebushi var. *schmitti* possesses the specific characters of *Macrostomum ruebushi* Ferguson (1939) but is distinct from the species and its other varieties and from all other species of *Macrostomum* heretofore described by the characters stated above in the differential diagnosis as may be shown by comparing these characters with those set forth in the key to the genus in Ferguson (1939–1940).

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[3] Obtained by the measurement under oil immersion of a dozen mature specimens.

ZOOLOGY.—*Studies on the egg-laying habits of the fairy shrimp.*[1] JOHN LAWRENCE AVERY, George Washington University. (Communicated by D. B. Young.)

During the course of life-history studies on the fairy shrimp *Eubranchipus vernalis*, certain data concerning egg-laying by this form were collected. It is the purpose of this paper to present these data.

In the female shrimp the eggs pass anteriorly through ducts on each side of the body until they come to lie in the brood pouch, which is a conspicuous saclike appendage located on the ventral surface of the female just posterior to the last pair of phyllopods. Located within the brood pouch is a horizontal paddlelike structure, pivoted at the center, which is in continual motion as long as eggs are present in the pouch. Its function is apparently that of keeping the eggs well aerated.

When they first enter the brood pouch the eggs are small, light-gray spheres. After a day or more they become almost twice as large and assume their final light-brown color. At the time of egg-laying, all the mature eggs in the brood pouch are expelled. Of all the shrimps under observation, only one (shrimp 6) expelled small, gray, apparently unfertilized eggs.

All the shrimps used in the experiment were of the same species, *E. vernalis*, and were collected from the same pond. Whenever possible, immature shrimps were selected to ensure the collection of all eggs laid during the life of the individual. Because of the difficulty of obtaining suitable food, large numbers of these young shrimps died before reaching the egg-laying stage. Only those that laid eggs are considered. For comparative purposes, several young mature shrimps were used. The mature and immature were separated on the basis of size, development of the claspers in the male and of the brood pouch in the female, and on general appearance. That these criteria were sufficient was later shown by the fact that within eight days after isolation all shrimps classified as mature had laid eggs.

In practice, one male and one female shrimp of approximately the same size were placed together in a 500-cc beaker containing either filtered pond water or conditioned tap water. Preliminary trials indicated that a temperature of 50°–58° F. was satisfactory for egg-laying. All shrimps were therefore kept within this temperature range.

The eggs, being heavier than water, sink to the bottom of the beaker. Examinations were made at frequent intervals and any eggs

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[1] Received September 11, 1939.

TABLE 1.—DATA ON EGG-LAYING BY *Eubranchipus vernalis*

Shrimp No	Date isolated	Age[1]	First batch		Second batch		Third batch		Fourth batch		Fifth batch		Sixth batch		Total No. of eggs	Average per batch	Date of death
			Date	No	Date	No	Date	No	Date	No	Date	No	Date	No			
11	3/15	M	3/17–18	8	3/24–26	9	3/26–27	24	4/ 7– 8	21	4/11–15	23	4/16–20	10	95	16	4/29
18	3/19	M	3/19–23	9	3/26–27	16	4/ 5– 6	10	4/ 7– 8	11	4/16–20	12			58	11.6	4/29
14	3/14	M	3/17–18	12	3/19–23	16	3/26–27	11	4/ 6– 9	3					42	10.5	4/15
23	2/27	I	4/ 6– 9	16	4/ 9–11	8	4/15–20	6	4/29–30	10					40	10	5/10
31	2/27	I	4/ 6– 9	5	4/11–13	14	4/15–20	12	4/22–26	26					57	14.2	5/15
6	2/27	I	4/11–15	38	4/16–20	7	4/29–30	6[2]							51	17	5/15
13	3/15	M	3/17–18	37	3/19–23	19	3/24–26	6							62	20.6	3/29
15	3/15	M	3/19–23	17	3/24–26	15	4/11–15	4							36	12	4/15
24	2/27	I	4/ 6– 9	14	4/11–15	4	4/16–20	3							21	7	4/20
16	3/15	M	3/17–18	19	3/19–23	13									32	16	3/27
30	3/26	I	4/ 5– 6	17	4/ 9–11	3									20	10	4/15
25	3/19	M	3/24–26	5											5		4/11
28	3/19	I	3/26–27	14											14		4/ 3
29	3/19	I	4/ 1– 2	51											51		4/15

[1] I, immature when collected; M, mature when collected.

[2] Several light-gray apparently unfertilized eggs also found on this date

found were removed with a pipette and counted. The results are shown in table 1.

These results show definitely that in *E. vernalis* the eggs are not retained in the brood pouch until released by the death and disintergration of the female, as has been reported for some shrimps. Neither have there been any cases observed in which the eggs hatched while retained within the brood pouch.[2] Unsuccessful attempts were made to hatch the eggs immediately after they had been laid. However, the writer has observed eggs laid in March hatch in November.

Six distinct depositions of eggs were laid by one female shrimp (shrimp 11) during the period between March 18 and April 20. An average of three batches of eggs was laid by each of 14 shrimps. The average number of eggs laid by each shrimp was 41.7 with approximately 14 eggs a laying. In the group collected as mature shrimps, females laid an average of 13.75 eggs a batch. In the group collected as immature shrimps the corresponding figure was 14.1. While there was no significant difference in the number of eggs to the batch, the individual shrimps in the group collected as mature specimens produced more batches, resulting in a greater average number of eggs to the individual. The greatest number of eggs laid by a female at one time was 51 (shrimp 29). However, during the spring of 1938 a mature shrimp was collected that laid 118 eggs during a 24-hour period. Another shrimp collected during the same season laid 165 eggs in two batches over a 5-day period. Such variations are probably caused by environmental factors.

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[2] MORGAN, A H *Field book of ponds and streams* 448 pp 1930 Putnam's, New York

ORNITHOLOGY.—*The starling's family life and behaviors.*[1] H. A. Allard, Washington, D. C.

In many parts of the United States and Canada the introduced starling (*Sturnus vulgaris*) has become one of our most familiar and abundant birds. While it is generally conceded that this bird is highly versatile and adaptive in its behavior, there is much to learn considering the daily activities of its summer family life, and the various manifestations of its gregarious life throughout the wintertime.

In February, 1929, the writer erected at the end of his barn an observation box, so constructed with a glass top in a darkened attic that one could at all times observe intimately every behavior of the parent birds and the young within, since the eyes of the observer were brought within 7–8 inches of the nest. This box was furnished with an entrance hole slightly over 1¾ inches in diameter, to admit the starlings readily. This is a matter of some importance since starlings can not pass a hole 1½ inches in diameter, which is sufficiently large for the entrance of bluebirds.

The following account is based mainly upon behaviors revealed by a pair of starlings which appropriated this observation box.

THE NEST

The starling is primarily a cavity-nesting bird. Old previously used nesting sites are preempted usually by the same pair of starlings throughout the season. Even throughout the wintertime the parent birds hold their respective boxes and, when not engaged in hunting food, spend the hours from dawn till dark fighting off meddlesome intruders of their kind, all the while indulging in their usual native loquacity and varied mimicry.

In February and March, or even in January, the starlings renew their nesting activities with an attendant increase in the power and variety of their vocal mimicry and expressions. They begin a very active inspection of the boxes and carry out and discard much of the old nesting material.

The new, clean observation box erected for them was quickly appropriated, and nest building began in March. Material, including mostly straw and grass stems, together with a few feathers, was very leisurely carried in by both sexes.

From the outset, the site of the nest depression itself was indicated

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[1] Received October 26, 1939.

by a circular space bare to the bottom of the box, which elsewhere was covered about an inch deep with a mat mostly of dead grass stems and leaves. The circular space remained bare, neatly and carefully surrounded by the nest foundation, which was built up around it. As this mat became deeper, the depression itself finally received a layer of fine grasses and some feathers, to constitute the final nest hollow destined for the reception of the eggs.

From time to time both birds added an occasional straw or feather to the nest even long after the young had appeared. Occasionally a green leaf was brought in, a behavior that is indulged in by a number of birds, more especially by the larger birds of prey, but the purpose of this green material is not well understood.

Throughout all the procedure of nest-building the male worked as diligently and as devotedly as the female, for the starling's home activities involve an unfailing cooperation between the sexes at all times.

INCUBATION AND BROODING

Five eggs were laid, but the exact dates of laying were not determined. Following laying the male was quite as punctilious and faithful in the incubation of the eggs as the female.

The carrying of food to the brooding parent by its mate was never observed at any time. This would seem quite unnecessary since both parents share equally in the work of incubation and brooding. When one leaves the nest the other is usually entering and at once takes its place.

Frequently one or the other parent has arrived at the box entrance and expressed its desire to enter with food. The bird within, however, maintains its claim to the nest and not even its mate can enter until it has left.

On April 21 four of the five eggs had hatched, one delaying hatching until April 22, and this belated bird was destined by these fateful circumstances to become the runt of the family.

While the fledglings were very young and helpless the mother starling, alone, brooded them at night. The male was never seen to do this, although during the day he was quite as solicitous of the family and did his full share of brooding at every opportunity. While the birds were very tiny and naked and temperatures were low, the brooding impulse was much more persistently shown. Later, as the young birds became larger and covered with feathers, they were left at night.

When brooding took place, the parent bird settled down over the young, always with the same characteristic procedure. This is done with a gentle sidewise wiggle into the final rest position. It would appear that this allows a better adjustment of the little birds to the parent's body, and is practiced by both male and the female.

FEEDING THE YOUNG

As previously stated, four eggs were hatched on April 21, and one on April 22. The young remained in the nest just 21 days. During this period development was rapid, from tiny, naked, blind, tottering mites of life to practically fully grown and feathered adults. This necessitated continuously changing adjustments on the part of the parents in supplying food to the young, in the sanitation of the nest, in brooding, etc.

Feeding began at once, both birds bringing in tiny caterpillars and other insects usually one at a time. These were usually crushed or macerated and very deftly and always very gently tucked into the tiny gaping throats. It was obvious that the parents seemed to realize that the tiny nestlings were in a helpless stage and required very dainty and gentle handling.

As the birds increased in size, there was a noticeable increase not only in the size of the caterpillars and spiders brought to them, but these were gathered by beakfuls, not singly as before. This change in the manner of feeding came about rather suddenly after the young birds were 6–7 days old. There was also a marked change in the manner of feeding, the very gentle profferings of the first few days giving place to more hurried and less solicitous jabs down the throats of the growing birds. There was of necessity a very evident speeding up of the entire round of family attention, involving more frequent visits with food, larger beakfuls, larger insect material, until finally, when the birds were half grown, hard-shelled June beetles, mulberries, and other bulky material were fed in a very impetuous manner.

Even after the young birds are fully grown and have left the nest, the starling families do not appear to disintegrate for some time. Although the young birds are well able to glean their own food, they may frequently be seen following the hard-worked parents around beseeching food. At such times it is not unusual to see the parents feeding them in the trees or on the lawns.

NEST SANITATION

It is obvious that where there are helpless young birds some degree of sanitation must be practiced so long as they remain in the nest.

This apparently becomes one of the great problems of the starling in the restricted room of their boxes and cavities. However, they make every effort to keep their young in a cleanly condition, and as the young themselves become older, they, too, become imbued with a sanitation impulse, which expresses itself in movements to or beyond the rim of the nest to deposit their excrement. The extent to which nest sanitation succeeds depends upon many factors, such as the industry of the parents, their mutual cooperation, the size of the nest box, the character of the food, the season of the year, temperature, etc. In very small crowded quarters, nest sanitation becomes much more difficult than in an airy, roomy box such as the writer's observation box.

Fecal deposition began as soon as feeding took place, and as the alimentary canal became filled the act almost regularly followed the feeding reaction. Both parents carried the fecal matter away, searching very circumspectly among the young for such material, picking up even the smallest particles. On a very few occasions this excrement was eaten, but this seems to be a very unusual behavior on the part of the starlings. The parents seemed to be quickly aware of fecal deposition and even appeared to watch a suspicious bird in the expectancy of this act, oftentimes, after each feeding.

Throughout the entire day, food was brought in usually with every visit, and excrement carried out on leaving. Only rarely did a parent bird enter without food or leave without fecal material. It was interesting to observe that when a parent bird brooded, it was instantly aware of the deposition of feces beneath it, probably from the feel of this extrusion upon its feet at times, and straightway it looked beneath and bore it away, to return quickly with food.

The starlings are early risers, and when the female had remained in the box at night to brood the very young birds, she left them at very early dawn even before it was light enough for her to seek food. However, during this pre-feeding period she busied herself industriously by carrying out fecal matter that had been deposited during darkness. Likewise in the evening, when the dusk had put an end to feeding operations, both birds continued to carry out fecal material so long as they could see.

At first the young were too weak and helpless to do more than defecate in the nest. Within four or five days from hatching, however, they began to evince a tendency toward nest sanitation of their own initiative. The young birds were making efforts to reach the side of the nest and scrambled over one another to take this position. After the sixth day many depositions took place at the very edge of the nest, and very soon these were placed beyond and well away from the nest rim. This tendency finally became an impelling mood, and near the beginning of the third week of their existence the young had established a defecating zone far beyond the nest and toward the opening of the box. This is shown in Fig. 1. The actual factors that determined the location of this zone are not known, but there is strong reason to believe that orientation was associated with the entrance hole and was dependent upon light or temperature conditions or both. Whatever the correct explanation, it is obvious that the young themselves, as soon as they were able, were governed by a sanitation impulse, and the adoption of this fecal zone greatly simplified the labors of the parents and resulted in better nest sanitation.

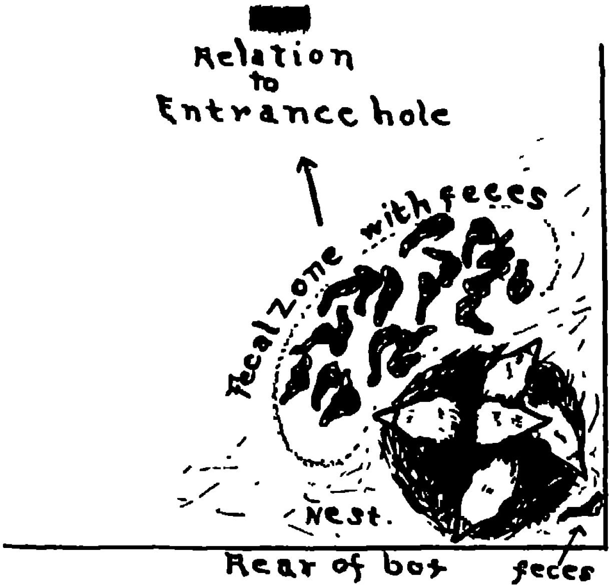

Fig 1 —Sketch showing the deposition of the feces in a well-marked fecal zone outside the starling's nest at the beginning of the second week of existence by the young nestlings It is evident that attention to personal cleanliness and nest sanitation has arisen in the behavior of the young birds in the course of their rapid development With the strength and control of the muscular system has come a conscious or subconscious psychic manifestation of sanitation, working most admirably in the direction of comfort and economy of the family association

MAKING THE BED

From the time the young appeared, and until they had become almost independent of the nest, the parent birds concerned themselves very much with the making up of the nest, as it seemed. This operation was performed with equal attentiveness by both parents. The parent stood astride the nestlings or among them and jabbed its beak everywhere deep down beneath their frail little bodies, evidently poking holes into the consolidated mat, perhaps to aerate it or to hasten drying. Whatever this procedure meant to them it was done very frequently and thoroughly and with such vim that one wondered how the tiny nestlings escaped being injured at times.

This shaking up of the bed was also performed by the brooding mother during the night, when she remained with the young for the first few days after they had appeared. Oftentimes at dawn when she finally left the box to feed or to seek food for the young, it was evident that the nest had been entirely remade during the night. This was shown by an obvious deepening of the nest bed and a bringing in of new and clean straw material and feathers from the mat within reach.

As one or the other of the parents has taken its position over the young birds to brood them, it has more than once been seen to reach out and seize a straw and poke it beneath its body. At other times it has picked up a loose feather and dropped it over its body so that it fell loosely over the head or body. Such material probably sooner or later falls into the nest and constitutes a new and clean lining.

REACTIONS TO EXTRANEOUS MATERIAL INTRODUCED INTO THE BOX

During the writer's study of the starlings' family life, various experiments were carried out. When the parents had gone, a great variety of material was dropped into the box, including pieces of flowers, green leaves, green shoots, bits of banana, fragments of paper, chewed wads of paper, wood shavings, prune seeds, and such animal material as May beetles, snails in the shell, cutworms, chrysalids, and angleworms, all of which had been immobilized by crushing to prevent their escape. Likewise small strawberries were dropped into the box. Much of this constituted the normal material fed to half-grown birds.

The green leaves were scrutinized critically but were usually allowed to remain, together with such material as small pieces of paper and dry wood shavings. All other material, of whatever nature, including May beetles, strawberries, etc., even though constituting the natural food when brought in by the parents, was unhesitatingly discarded. Such material as paper, bits of leaf material, etc., that could be incorporated into the nest appeared to pass as nest material and was allowed to remain. Food substances of whatever nature, however, appeared to fall into the category of waste material comparable to fecal matter and were usually very promptly discarded.

Strangely enough, if the parent bird dropped an insect morsel while attempting to feed a young bird, it invariably picked this up and offered it again. On the contrary, insect material found in the box or nest was never directly fed. In one instance a roach dropped into the box was quickly carried out by the returning male, and when he reappeared he offered a ground roach to the young. Whether this was the same roach previously dropped into the box can not be established, as these insects were sometimes brought to the young.

The placental structure of a large green pepper with the seed attached was dropped into the box in the absence of the parents. This object was nearly as large as the entire dimensional size of the young. It was casually inspected by the first bird to enter the box but was untouched. However, when accidentally knocked into the nest by one of the parents returning later with food, it was finally carried out of the box, but not without some effort owing to its weight and bulkiness.

SOCIAL RELATIONSHIPS

The starlings at all times are more or less gregarious in their relations. Even when the family burdens of the summertime break up their great winter aggregations, they remain friendly to one another and never entirely lose the helpful social spirit. Unlike many other more individualistic and independent birds, they appear to evince no definite territorial claims and forage and feed wherever they choose, oftentimes together.

The starling is very largely a ground feeder. As it scrutinizes the grass and ground debris it has a very characteristic habit, peculiar also to the grackle and perhaps to various other blackbirds. As it thrusts its beak into the grass and ground debris, it spreads the mandibles apart with every thrust, either to enlarge the hole its beak has made or perhaps to feel with its tongue. Whatever the purpose of this behavior it is an invariable racial trait. The starling never scratches in the ground debris as do the chewink and many sparrows and never tosses the loose debris about with its beak as does the brown thrasher.

Although the starling is preeminently a ground feeder, preferring lawns and open fields for its foraging, it is inordinately fond of mulberries and very readily distinguishes the ripe black fruits from the red green ones. To this degree its color sense is highly developed.

In the wintertime when the gregarious mood has reached its height, the flocking impulse is a marked feature of all its behaviors. It flies from its city rendezvous to the country to feed by day, and returns in the evening, often aggregated into enormous flocks, whose precise and synchronized maneuverings are marvelous to behold.

In the wintertime the starlings are wont to feed in similar formations, which move very systematically over a field as the birds walk along. However, with their keen insight those in the rear of the formation realize that the new territory just ahead of the advancing front line is likely to afford the choicest morsels. These then constantly arise and fly ahead and descend to become in their turn briefly the front line, for they too, will soon be replaced by others flying up from the rear. Thus the foraging flock moves along smoothly, partly by walking and partly by flight, enabling all the members to have their chance in the scrutiny of new ground, which otherwise would be denied those always remaining in the rear.

The starlings cling very tenaciously to the boxes and nesting sites they have preempted and will fight almost to the death any interlopers of their own kind, or even other birds. The writer once found a pair of females locked so tightly together by beak and claw, as the result of a combat, that both birds lay helpless in the box, and when picked up could only be disengaged with much effort. How long they had lain thus is not known.

In the writer's trees the flickers fought bravely to oust starlings from their boxes, but they were no match for their smaller and more agile adversaries. On several occasions a flicker struck at a starling with great force, but his blows were too slow and deliberate to reach his more active enemy. On several occasions the starlings showed tendencies to gang up against the larger bird and were frequently seen to cling tenaciously to their feathers in their attacks.

The story was entirely different with the little screech owls that nested next door to the starlings. The latter never ventured into the owls' quarters, although on several occasions the little owls at dusk were seen peeping into the starlings' homes. In spite of their hatred of the owls, both birds carried on their economies in close proximity, but it was plainly obvious that the starlings merely accepted the inevitable quietly, since there was nothing else to do.

Occasionally a small hawk appeared; then the starlings became

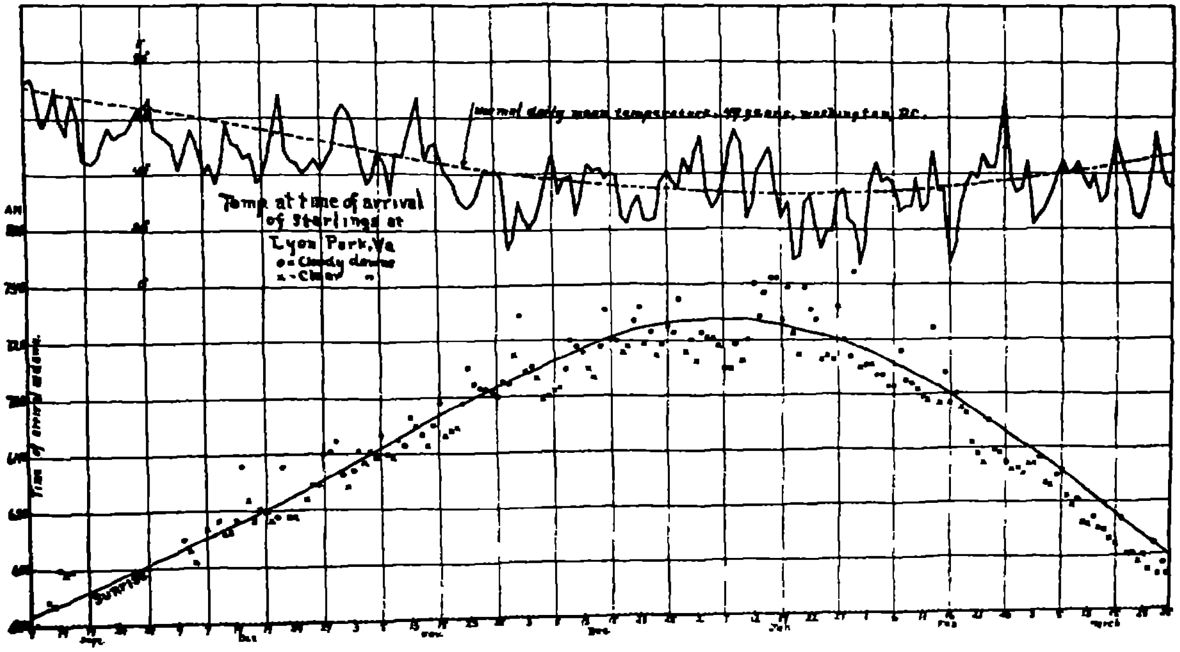

Fig 2.—Time of dawn arrival of the starlings at Lyon Park, Va 1929–30, in relation to the sunrise curve (E S T) and temperature at time of arrival Broken line shows the normal daily mean temperature at Washington, D C , for 49 years

alert and even gathered into bands and flew about ready to persecute it with their disconcerting maneuverings.

During the summer when the female remained with the tiny young at night, the males appeared to roost nearby in pine trees. Later when neither parent remained with the young birds, the males and females appeared to repair to their respective roosts somewhere near at hand. In autumn, when the flocking urge is at its height, both parents, apparently still mates throughout the winter season, fly to and from the city where they spend their nights.

The time of leaving the nesting box at night and of the arrival at dawn depends upon the factor of light intensity, and these curves follow closely the curves for the seasonal time of sunrise and sunset (Figs. 2–4). During the winter season, however, those light intensities that send the birds to roost are far higher than those that drive them to roost in summertime, as if they were very loath to leave their young. It is highly probable here, however, that we have marked seasonal differences in physiological sensitivity of the eye to light, owing to the very different hormonal organization expressing itself at the two seasons.

DISCUSSION

We have followed some of the more striking behaviors of a family of starlings from the time of nest building to the maturity of the young birds and the final abandonment of the nest by these exactly 21-22 days from the hatching of the eggs. It is evident that there are many outstanding behaviors in the starlings' life history concerned with nesting, incubation, feeding, and sanitation that are of much interest.

In the first place, a remarkably close cooperation between the male and the female obtains in all the essential activities connected with the preparation for and the raising of the family.

The male aids in nest building, incubates the eggs, feeds the young, and attends to the cleanliness of the nest with as much interest and punctiliousness as does the female. There appears to be one phase of duty, however, that he does not normally assume. The female, alone, appears to remain with the tiny, helpless young for the first few nights of their existence.

The writer has heard it stated that starlings are filthy birds, but this can not apply indiscriminately to all starling parents. It is probably nearer the truth to say that starlings do their best to maintain clean nests for their families.

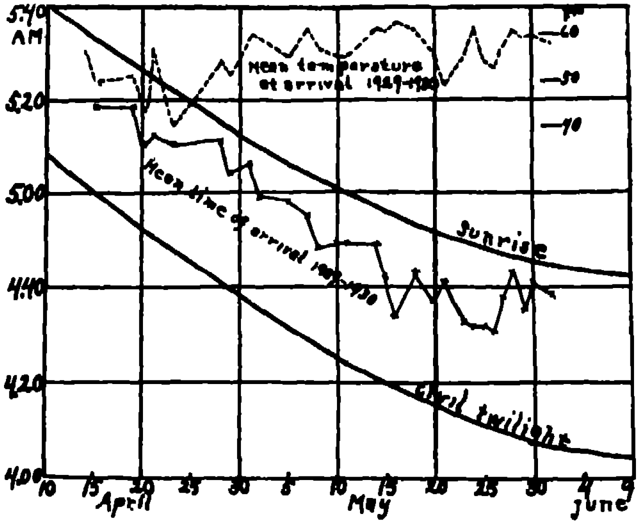

Fig 3 – Mean time of arrival of the starlings at Lyon Park, Va , derived from the data of 1929 and 1930 The two-year temperature mean at the time of arrival is also shown The correlation between sunrise and the two-year mean for the first arrival for the years 1929–30 as obtained was 0 962 ±0 009 The correlation between the two-year mean of first arrival and the two-year temperature mean was found to be –0 482 ± 10

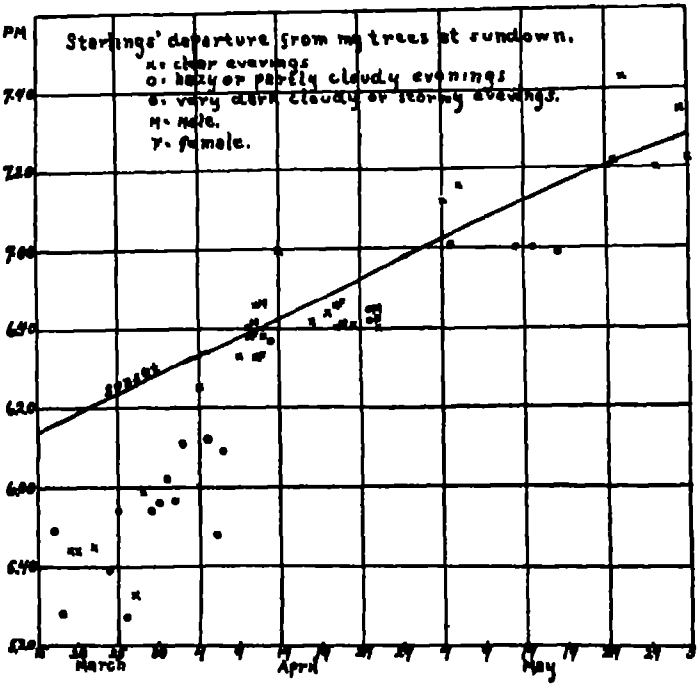

Fig 4 – Departure of the starlings from trees of the writer at Lyon Park, Va , at sundown, 1930, in relation to sunset (E S T)

Should one or the other parent die, there is every reason to believe that the remaining parent would assume the care of the family to the best of its abilities. In such an event it is probable that the usual degree of cleanliness of the nest could not be so successfully maintained as when two conscientious mates were working industriously toward the same end.

Nest sanitation is a real necessity for the health and comfort of the young birds, and many factors must modify the degree of success attained, one of no small importance being the roominess of the cavity holding the nest.

It is obvious that the young themselves very soon evince tendencies toward cleanly habits, which has finally expressed itself in the adoption of a definite fecal zone entirely without the nest. We have, here, the foreshadowing of the localized or latrine concept, which some animals have evolved to a high degree.

Where sanitary conditions have not been maintained, for one reason or another, conditions may become so filthy as to cause the death of the young birds In one instance a young bird that had left its nest nearby was scarcely able to use its legs from the enormous thickness of the excrement dried and accumulated upon them. It required much effort and washing to free this bird of its filth, and it would probably have died had it remained in its befouled condition. It is not known what causes were responsible for this.

It has not been determined whether unattached birds—one may call them widows, spinsters, or bachelors—ever enter into the care of a starling family, where one or both parents die. It seems probable that this may occur, however, for on several occasions when the legimitate parents of the family under observation were away, strange starlings have occasionally appeared at the box entrance to peep in curiously. These are quickly driven away when the parents arrive.

One of the most striking features of starling behavior is the rigid observance of carrying out all introduced material, food or otherwise, that has been dropped into the box. It would appear that all extraneous matter not brought in by the parents themselves, even though it may be acceptable food, is treated as if it belonged in the category of excrementitious material.

Some biologists would explain all the niceties of adjustment and accomplishment we have observed as an example of a train of mechanized integrated behaviors from which there was no escape. The writer feels that we can not talk too dogmatically on this point. At times there seems to be some element of experienced judgment in operation as much as anything else. It is obvious that rarely has there been any useless, accidental behavior shown, all behaviors operating smoothly, rapidly and progressively to meet in a timely manner, all the needs and adjustments demanded by a rapidly changing developmental cycle.

The writer does not feel qualified at the present time to say what moods in these behaviors are consciously reasoned and what are purely mechanical, to be dogmatically referred to reflexes, tropisms, or whatnot. Even we, in our highly civilized moods, at times show many instances of mechanized, stereotyped behaviors that have no longer logical meaning for the situation, as when we cling to archaic procedures simply because they are sanctioned by custom or habit or had become legal usage long ago.

A study of the starlings' behavior and family life indicates a very high order of bird intelligence throughout and a close attention to all phases of the family welfare. It is evident that the intimate understanding and cooperation of the two parents in all the stages of preparation for and the care of the family have helped to make the starlings highly adaptive and successful birds wherever conditions are favorable for their survival.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE ACADEMY

COMMITTEE ON CATALOGING SCIENTIFIC SOCIETIES OF WASHINGTON AND DEFINING QUALIFICATIONS FOR AFFILIATION

As its meeting on November 10, 1939, the Board of Managers received and accepted a report from a committee, consisting of C P. Clausen, F. M Defandorf, W D Lambert, J E. McMurtrey, Jr, and W T. Schaller (chairman), dealing with the cataloging of the scientific societies of Washington and the definition of the qualifications of a society for affiliation with the Academy

To be eligible for affiliation the given scientific society, association, or club must be concerned with natural science, with the social, economic, or historical sciences, or with any phase of engineering; must hold its meetings within an area that includes the District of Columbia and the territory lying within 25 miles of it; must have a membership of whom the majority reside within the area indicated; must have a regularly constituted organization with elected officers; must concern itself primarily with the search for facts and truths rather than with the popularization or commercial exploitation of them; and must have at least an effective nucleus of members actively engaged in pure or applied scientific research who control the policies of the society.

The list of scientific societies, associations, and clubs reported by the present committee, which completed work begun by an earlier committee of the

Academy, includes (1) regularly organized bodies that hold their meetings within the District of Columbia or the territory lying within 25 miles of it, (2) local sections of national societies and associations, (3) national societies that have their headquarters in the indicated area, and (4) scientific organizations affiliated with universities and colleges in the given area The list is printed here with a request that readers will please notify the editors of the JOURNAL of appropriate corrections or additions·

Academy of Medicine of Washington
Agricultural History Society
American Anthropological Association
American Association for the Advancement of Science
American Ceramic Society, Baltimore-Washington Section
American Chemical Society
American Engineering Council
American Fisheries Society
American Forestry Association
American Genetic Association
American Geophysical Union
American Horticultural Society
American Institute of Architects
*American Institute of Electrical Engineers, Washington Section (1912)
American Institute of Mining and Metallurgical Engineers, Washington Section
American Iris Society
American Nature Association
American Orchid Association
American Ornithologists' Union
American Pharmaceutical Association
American Phytopathological Society
American Society of Agricultural Engineers, Washington Section
American Society of Civil Engineers, District of Columbia Section
American Society of Heating and Ventilating Engineers, Washington Section
*American Society of Mechanical Engineers, Washington Section (1923)
American Society of Metals, Washington Chapter
American Society of Naval Engineers
American Statistical Association
American Therapeutic Society
American Welding Society
*Anthropological Society of Washington (1898)
*Archaeological Society of Washington (1902)
Association of Military Surgeons of the United States
Association of Official Agricultural Chemists
Baird Ornithological Club
*Biological Society of Washington (1898)
*Botanical Society of Washington (1902)
Catholic Anthropological Conference
*Chemical Society of Washington (Section of the American Chemical Society) (1898)
Chemists' Club (Georgetown University)
Colonists, The
*Columbia Historical Society (1899)

* Affiliated with the Academy. Date indicates year of affiliation

District of Columbia Dental Society
District of Columbia Homeopathic Medical Society
District of Columbia Optometric Society
*Entomological Society of Washington (1898)
Genetic Club, The
*Geological Society of Washington (1898)
*Helminthological Society of Washington (1923)
History of Science Society
Horological Institute of America, Inc
Insecticide Society of Washington, The
*Institute of Radio Engineers (1933)
Maryland State Horticultural Society
*Medical Society of the District of Columbia (1898)
Metropolitan Section of Model Engineers, Inc.
National Academy of Sciences
National Aeronautic Association of the United States of America
*National Geographic Society (1898)
Paleontological Society of Washington
Patent Office Society
Petrologists' Club of Washington
*Philosophical Society of Washington (1898)
Pick and Hammer Club
Society for Experimental Biology and Medicine
Society for Philosophical Inquiry of Washington
*Society of American Bacteriologists, Washington Branch (1923)
*Society of American Foresters, Washington Section (1904)
*Society of American Military Engineers (1927)
Society of Automotive Engineers, Inc., Washington Chapter
Society of Woman Geographers
Washington-Baltimore Psychoanalytic Association
Washington Biologists Field Club
Washington Camera Council
*Washington Society of Engineers (1907)
Wild Flower Preservation Society
William Beaumont Medical Society (George Washington University)

COMMITTEE ON CERTIFICATE OF AWARD

The Committee on the Certificate of Award of the Academy, consisting of H. B. HUMPHREY (chairman), B Y. MORRISON, and R. E. SNODGRASS, reported to the Board of Managers on December 1, 1939, concerning a suitable certificate of award to be granted to the recipients of the scientific awards recently established by the Academy. The committee was instructed to proceed with the provision of the certificates

JOURNAL
OF THE
WASHINGTON ACADEMY OF SCIENCES

VOL. 30 FEBRUARY 15, 1940 No. 2

BOTANY.—*Naming molds.*[1] CHARLES THOM, U. S. Bureau of Plant Industry.

I owe an acknowledgment to this Society for rehabilitation as a botanist. The office I am laying down tonight was my first elective position in a botanical society. I gave up a graduate assistantship under Atkinson at Cornell to turn dairyman in 1904, and that spelled heresy to some. In that period, I once joined the crowd outside the dining room door at the Annual Dinner for all Botanists. Some one presented me to one of the elect who looked at me rather sharply and said, "I don't remember any Thom as a botanist." I replied, "All right, call me a dairyman." He answered, "Oh, then I do know you!" I never found out who he was and have always wished I had made sure of his name. I should like to meet him right now.

When I left Cornell, I was assigned to the mycological phases of producing certain varieties of cheese already recognized as ripened by molds. My knowledge of molds was vague—I was superficially acquainted with a few Mucorini, and with one or two bright-colored Aspergilli; I was vaguely conscious of the general appearance of *Penicillium* and a few more of the common genera. I knew nothing at all of the technological task that I had acquired. Professor Atkinson had written the recommendation. He was frank about it; he assured the appointing power that he knew nothing about the project, neither did Thom, but that he had more work already than he could do, whereas Thom needed the job and had brains enough to fill it. No superlatives appeared (I have read the letter). I thanked him and reported for duty. You will readily understand that you are attending a kind of confessional or experience meeting where the confessor has spent some 35 years working with molds.

AN INDUSTRIAL MYCOLOGIST

Thus I became an industrial mycologist. I entered a field in which existing mycological literature was mostly useless and in which the be-

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[1] Address of the retiring president of the Botanical Society of Washington, December 5, 1939. Received December 6, 1939.

ginner was left to feel his way among materials, factory processes, ripening conditions, and biochemical aims, all unknown to him and only vaguely known to his fellow workers who were dairymen, bacteriologists, and chemists. In some groups of botanists, my status as apostate was quickly evident. It was several years before I dared to face a botanical club, point to a distinguished ecologist in the room, and say, "I am an ecologist—just as much as my friend over there. The only difference is that I make the environment for my organism while he goes out and hunts for his." Academically, then, an industrial mycologist must be an experimental ecologist, and the user of ecological studies quickly learns that sound taxonomy is the essential background of ecology. Failure in the correctness of identification of the components of a plant formation in the field destroys the value of a report.

Nevertheless, as a beginner I was about in the fix of the rookie cavalryman who had never learned to ride but reported to the top-sergeant for training in horsemanship. That hard-boiled individual blurted out, "What? Never been on a horse before! Fine! Here is a horse that's never been ridden. You two may begin together."

Professor Atkinson was right—none of us had more than the vaguest idea of the task before us. When we went to the literature it paralleled closely a fellow-worker's characterization of the German literature about sauerkraut—"it was very extensive and not worth reading." Many cheese-ripening practices were described in countries of origin as "rule-of-thumb" procedures in which climatic or other factors supplied conditions often not defined even in the worker's mind, but actually necessary to success. However inadequate the available technological descriptions, the mycology was worse.

The molds present in the cheese industry were not difficult to isolate. Rigid preliminary survey did not leave many doubts as to which were significant. Verification involved technical problems that required years of experiment after the organisms were recognized. But when I started to find out what was already known about those molds I was in trouble.

My connection with the taxonomy of saprophytic hyphomycetes began at that point and has since led me in many directions. Some of this experience will be discussed here. If at any point I may seem to generalize, please remember that the title of this paper is just "Naming Molds"—not "Systematic Mycology"—however widely I might be tempted to apply my ideas.

Why give Latin names to those wretched little molds? I can not answer, fundamentally, but I can make the trite observation that the human mind works that way. The objects one meets get named. If we are to understand each other then, we must be able to find out what the names used by our fellows mean. Thus far the reasoning is purely practical. For illustration, I once ran across a doctor of philosophy to whom the word butter meant apple butter; if you meant the stuff made from cow's milk, it was necessary to call it cow's butter to make him understand. And *he* took a job in the dairy! A name then, to be useful, must be an *accepted* designation for a very definite thing.

Mold information, whatever its value, is indexed under the Latin names of the molds themselves. And sometimes it is not very dependable. For illustration, one very up-to-date practical and modern journal in a perfectly proper technical article, published a new species name and description a few years ago for a mold so well known among culture men that nobody but the author and the editorial committee could possibly have failed to have met it before. Since it was new to that writer, he had burst into print with his one and only new species. Judged by the tables of contents, that journal puts no limitation upon the rotten practice of the "discovery" of an organism new to the "one-project worker" who thereupon prepares a description based upon his own lack of contact with the literature of the group and sends it forth to plague all subsequent students with the addition of another synonym, or, upon the equally obnoxious practice of collecting all the miscellaneous organisms occurring in connection with a special problem, labeling as new species all those that the sender does not know and sending them to a specialist to identify, always reserving the right to describe any organism that the specialist verifies as new. Such men, not being mycologists, escape the ban.

Let us get back to our cheese molds. The technological writers had copied Latin binomials from the books, with confidence, and added the describer's name in each case. *Penicillium glaucum* Link, *P. candidum* Link, *P. album* Preuss, and several other molds were listed without question marks. When I searched the cheese literature to find out how they had sorted out names and fungi, I was driven to believe they did it by Fisher's method—"at random."

Then I tried the mycological literature to see what the names had originally meant. I worked paper by paper back to Preuss (1851), then back to Link (1809). I went on back to Micheli (1729). Many believe that Micheli intended *Penicillia* by one of his figures, but it is too doubtful to trouble us now.

PENICILLIUM

There is no question about Link's generic idea of *Penicillium*, but there is no evidence as to which actual species he had when he described either *P. glaucum* or *P. candidum*. One man's guess is as good as another's—or as Link's (yes, or Brefeld's), for that matter. Link did not know his *P. glaucum* from any one of 100 green molds. Fifteen years later he put the whole green lot together and called them all *P. glaucum*, which was designated "the common green mold" in the fourth edition of the *Species plantarum* (1824). And the idea crops up yet, after more than 100 years!

Occasionally some one raised a doubt about a universally distributed green mold that grows upon and in everything, but the name was convenient; it satisfied the pedantic requirement for a Latin binomial to be applied to material that people were not willing to study. All local fungous floras report it. The popular writers accepted *P. glaucum* as *the green mold*, chemists took it up and tested "its" activity against every kind of substratum and reagent. With probably a hundred green species to pick from, *at random*, each was able to expand the range of biochemical activity reported. Naturally with different agents, contradictions crept in and raised controversy between individuals, but the popularity of *P. glaucum* was not abated—the mistake was always charged against the worker. *Penicillium glaucum* was sacred to the shades of Link and Brefeld.

A LIVE PROBLEM

I might go on and tell more of the story of nomenclature in *Penicillium* and *Aspergillus*, but all that has been published—and the indexes are good. Suppose I shift to a problem of nomenclature that is worrying a whole group of men today, and hang a general discussion around it.

These men work with human mycotic diseases; they have had experience in the great laboratories of the world; they have excellent instruments and refined technique; they have access to literature. From a series of rather horrible lesions on perhaps 60 patients living in widely separated places, they have isolated a number of strains of mold with certain characters in common and differences that offer a chance for individual judgment in classification. Between 1915 and 1939 these cultures have been assigned to about a dozen genera even though it is doubtful if there are really more than three species. These men disagree among themselves. I have been asked several times to express an opinion as to which is the proper name, but I hardly expect any of them to accept my conclusion. The real question, however, is: Why is there so much disagreement when the descriptive data are not only readily established but in fact generally conceded?

A sketch of the nomenclatorial situation is necessary.

In 1915, a medical worker in Boston described a skin disease but without very definitely naming it. From the lesions studied he isolated a fungus that he decided belonged to an undescribed genus and species: *Phialophora verrucosa* Medlar

In 1920, A. Pedroso and J. M Gomes, working in São Paulo, isolated a similar organism from cases of Chromoblastomycosis. They accepted the same name, *P verrucosa*, which has since been commonly cited as originated by Thaxter

In 1921, Brumpt decided that the São Paulo fungus was not Medlar's organism but another species he called *Trichosporium pedrosoi* Brumpt. (Brumpt worked for a period in Brazil about that time.)

In 1922, Brumpt, having restudied the old literature, resurrected Bonorden's generic name, *Hormodendrum*, and changed the name to *H. pedrosoi*.

In 1922, Terra, Torres, da Fonseca, and Areo de Leao, in Rio de Janeiro, called the same organism *Acrotheca pedrosoi* (Brumpt) T. T. de F. and L.

In 1928, Ota distributed material under the name *Trichosporium pedrosianum* but later decided not to publish that species name.

In 1929, Langeron (Ota and Langeron collaborated about that time) again assigned Ota's mold to *Trichosporium pedrosoi* (Brumpt, 1921).

1930, da Fonseca and Areo de Leao again published the name *Acrotheca pedrosoi*

In 1935, Dodge resurrected the name *Gomphinaria* from Preuss's 1851 paper and moved the species to that genus.

In 1936, Negroni proposed another new name, *Fonsecaea*, calling the fungus *F. pedrosoi* (Brumpt) Negroni.

In 1937, Moore and Almeida, after collecting and comparing strains, added three more generic names for the variations encountered, basing the usage upon the presence and combinations of spore-bearing structures These names are *Botrytoides*, *Hormodendroides*, and *Phialoconidiophora*

In 1939, L. Briceno-Irragorry proposed another generic name, *Carrionia*, with *C. pedrosoi* (Brumpt) as its type species, arguing that this genus should include the organism of Chromoblastomycosis in South America.

CADOPHORA

In the field of forest pathology, Lagerberg, Lundberg, and Melin (1928) found species with the sterigmatic cups, which characterize the genus *Phialophora*, upon woody materials both in America and Sweden. They proposed the generic name *Cadophora* for those forms without recognizing their essential identity with *Phialophora*. More recently morphological and serological comparison of materials from human and forest sources in culture (Conant, Martin) supports the identity of these genera, hence *Cadophora*, 1928, gives way to *Phialophora*, 1915. From the epidemiological point of view, however, Emmons (personal communication) finds grounds for belief that human infections find their inoculation in spores or mycelium from the plant-inhabiting fungi rather than from those upon fellow humans. As far as cases have been studied, man-to-man communication seems to have been excluded; hence he holds that we must search in the field among fungi growing upon vegetation for the strains responsible for cases of Chromoblastomycosis in man.

If further field study proves that these organisms are members of species regularly found upon decomposing plant remains, occasional infection of an individual human by spores or mycelia from such plant material does not warrant the establishment of either a genus or a species for that organism as a parasite. Many of these strains have grown well for me on sterilized plant material. This supports the view that search for them by culture from field samples offers a hope for solving some of these problems. Miscellaneous observation of great numbers of colonies of this dematiaceous series in connection with soil and food microbiology shows quite general growth at 37° to 38° C.—a condition usually regarded as a prerequisite to parasitism of warm-blooded animals.

HORMODENDRUM OR CLADOSPORIUM

The identification of these fungi from human lesions as congeneric at least with saprophytes or parasites of plant material turns our quest for nomenclature back to such older names as *Hormodendrum.* Bonorden (1851) distinguished his genus *Hormodendrum* from *Cladosporium* of Link (1816) by only one tangible character. Link had reported the spores of *Cladosporium* as 2-celled. Bonorden described the spores of his genus as 1-celled and transferred to it four species described by Corda as *Penicillia* but without personally seeing any of them, then added some "*Penicillia*" described by Fresenius, making a few disparaging remarks about Fresenius (1851). Two years later (1853) he clarified his ideas of *Hormodendrum* by actually describing one from fresh material (*H. atrum*). He left little doubt as to the general morphology of his mold.

Bonorden in his discussion clearly admitted that his material may, at least in part, have already borne the name *Cladosporium.* Among mycologists familiar both with specimens from the field and with the molds in culture, the 1-celled or 2-celled condition of the conidia is found utterly unreliable; hence the identity of *Hormodendrum* with *Cladosporium* has been quite generally conceded for 50 years at least.

As a consequence, application of the rules of nomenclature relegates *Hormodendrum* to synonymy.

Although Link's description of *Cladosporium* is no more definite than the other abbreviated Latin diagnoses of that time, the general nature of his material appears to have been recognized and the information handed down through continuous usage in the mycological laboratories and collections of his own and succeeding generations of workers. In this way his concept became more definite than *Dematium herbarum* of Persoon, which he believed to be the same material.

HISTORY OF CLADOSPORIUM

Before 1816, Link had assigned such forms as *Dematium herbarum* of Persoon to *Acladium* in 1809, after presumptively satisfying himself that they should be separated from the other species left in *Dematium.* Later he must have looked at them more carefully and concluded that they should be excluded from *Acladium* (branchless) and put into a genus whose name pointed to the distinctive character, branching (clados) spore chains. The code of nomenclature we use today for these groups of fungi begins to apply the priority rule with Fries's *Systema mycologicum* (1921–1932), rather than the previous publications of Link, Fries, or Persoon. Up to that time such arbitrary changes as we find in Link, Persoon, or even Fries merely furnish background for understanding the conditions under which the usages we have today were developing. *Cladosporium* is definitely recognized by Fries; hence it is valid.

CLADOSPORIUM OR SOME SEGREGATE

If, then, our reasoning is correct, these fungi isolated from Chromoblastomycosis must be assigned to *Cladosporium* unless adequate characters are available to separate some one or more of the series into one or more other genera. Without repeating details, I have already noted that the more careful workers agree that all the strains in question are closely related, at least (Emmons and Carrion, 1936).

In seeking lines for separating the series, describers have emphasized three kinds of spore production. All agree on the observation of some strains predominantly producing the *Cladosporium* or, to use their term, *Hormodendrum* type of spore chains: i.e., a more or less complex system of branching chains in which the newest cells or spores are constantly developing on the tips of the branches. They equally agree that other strains show progressive reduction of the branching system toward the ultimate simplicity of clusters of primary spores aggregated rather densely about the clavate ends of the fertile hyphae (suggesting *Botrytis* to Moore and Almeida). Only an occasional individual cell in these groups develops a short series of buds of the *Cladosporium* type—some of them call this the *Acrotheca* type of spore formation. The fact of progressive reduction but never complete reduction, from the complex *Cladosporium* type of branching chains toward the *Acrotheca* type, leaves the homologies definite and readily recognizable.

PHIALOPHORA MEDLAR[3]

In contrast, the third type of fruiting structure is that described for *Phialophora*. Medlar figured hyphae with black or brown walls upon which directly or on short branches, singly or clustered, basal or sterigmatic cells develop. These cells termed by him phialids have firm brown to black walls and contract abruptly near the tip into spore-producing tubes, which then abruptly flare to form cups or cupules also with heavy brown walls. Colorless, thin-walled spores develop successively within the bases of the cups and tend to adhere about the tips in more or less sticky masses or spore balls. My statement is one of observation that they develop there but not how they are formed.

This structure is known to many mycologists from its presence in other series of imperfect fungi. In some species it is reported to be functional in connection with producing the ascosporic phase of life history. Outside of appearances in lesions, the life histories of the fungi of Chromoblastomycosis are entirely unknown; hence these cupules are for the present merely additional morphology, which can be used in diagnosis. Some species or strains show them regularly, some under limited conditions, while they are not known in other strains.

In culture, Miss Margaret Church and I studied the "*Cadophora*" type of structure from decaying plant materials at least 15 years ago. I have examined an occasional culture from pathogenic sources. Finally Dr. Emmons passed me 20 cultures from his collection, including transfers of strains received from Dr. Morris Moore as representing *Phialoconidiophora*, *Hormodendrum*, and *Botrytoides*. I have kept them in petri-dish and test-tube cultures for at least two months. It requires no imagination to find colony differences perhaps justifying separation into species, but essential similarities are equally apparent. I can find no reason for separating them widely. I can not agree that they should be placed in different genera.

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[3] Not Thaxter! Even though Medlar acknowledged consulting Thaxter, he took entire responsibility for the naming and description of his species. Citation of the species as *P. verrucosa* Thaxter is common but unauthorized by any rule.

Then how about selecting a generic name from the available dozen and putting them into it? The objection is raised that particular names are based upon the presence of particular types of spore formation, while in the cultures these do not always satisfactorily correspond with any one of the descriptions. If the group of strains from human sources appears to be too homogeneous to place in separate genera, as I think, the priority rule settles the question without further debate. *Phialophora verrucosa* of Medlar was certainly one of the series and was described first. A generic name once established loses its etymological limitation and becomes the designation of an aggregate rather than a unit or single species. Medlar's organism would be the type species. His generic description would need emendation, but that is readily furnished. Such a separation appears to be justified by the preponderance of observations to date and should be broadly enough established to include some at least of the '*Cadophora*" series described by Lundberg, Lagerberg and Melin, and others. The student of this "*Cadophora*" series upon vegetation and in culture is sufficiently impressed with its contrast in colony and spore producing characters in comparison with the "*herbarum*" lot in *Cladosporium* to be unwilling to assign them to *Cladosporium;* hence he would choose the alternative of broadening the generic diagnosis of *Phialophora* to cover the series showing these common characters until further life history studies determine real relationships elsewhere, if any. In other words, as I see it, the well-established saprophytic series "*Cadophora*" determines the placement of the vagrant members of that series which are found here and there throughout the Western Hemisphere as the cause of Chromoblastomycosis in individual humans, each time apparently *de novo.*

EPIDEMIOLOGICAL ARGUMENT

Epidemiological isolation of these cases clearly disposes of any necessity to recognize the parasitization of the individual human as justifying the separation of the causal organism, as isolated from the patient, generically or specifically from the inoculum that produced the lesion. Each organism isolated from such a lesion is to be considered merely a stray member of a species abundant in another environment. Such an occurrence is not essentially different from growth in a petri dish, which frequently diverges in superficial characters from the colony as seen in nature. In this series, then, the imaginary wall between fungi growing on vegetation and as fungous parasites of man has broken down. As in many other biological situations, the idea of specificity which limited organisms to particular and narrow biochemical roles proves to be false.

BACK TO BIBLIOGRAPHIC HISTORY

Having illustrated my topic by proposing an answer to a specific question, I must now go back and discuss the broad aspects of my task—naming molds. The causes of such controversies as I have just described lie back in the history of mycology covering the past 200 years. The original mycologists were essentially microscopists—laboratory examiners of material, who applied rapidly evolving microscopic methods to the description of specimens collected by themselves or others. I am sorry to express the conviction that there are many today who go little farther in their examination than Link or Persoon even though with better microscopes and more adequate literature they can not avoid seeing more.

THE FIRST 100 YEARS

If we follow back the descriptions of molds to Micheli (1729) we find that he separated the half dozen or so molds that he called *Aspergillus* (rough headed) as yellow, white, green, black, etc. There were 2 or 3 Asperigilli, probably a *Penicillium* or two, or some Mucors among them. Color seemed to him all he needed for separation. By the beginning of the nineteenth century, Persoon and Link, with a larger series of molds to separate, had raised the requirement to 3 or 4 lines of Latin. Their figures clearly indicate that their microscopes were low in magnification, but their descriptions and figures seemed adequate to men who had only a few forms to separate but did not help the next fellow who had only a few, but a different few. Details of structure and cell arrangement were not seen and were not thought necessary.

Corda (1830–1840) went a bit farther—he had a better microscope and figured individual cells, but their origin and relationship were not even considered among his recorded data. Corda could draw nice pictures—the only trouble with them has been that no one else has ever been able to find anything like his pictures of some of these evanescent molds, however valuable his drawings may be in other groups.

By 1850 Montagne concluded that most of these old descriptions of delicate fungi were entirely uninterpretable.

These men were busy naturalists—explorers of the new domain opened up by the compound microscope. Their colleagues were clamoring for information. Collectors in distant lands piled the tables of Linnaeus, Persoon, Link, Fries, Berkeley, Cooke, and the rest with unknown specimens. What wonder that each described in hasty terms everything that came or matched it briefly against his predecessor's briefer description, then identified or separated it and passed it into his collection. Unfortunately, most of these specimens of the more delicate fungi kept even under the most careful management quickly dried up, separated into powder, and disappeared. Verification from type specimens is thus impossible.

CULTURE ENTERS THE CONTROVERSY

Culture did not appear in the mycological literature until the time of deBary, about the 1850's, and was not used seriously for descriptive purposes before van Tieghem in the 1860's and Brefeld in the 1870's.

Brefeld did a prodigious amount of work, but he also was an artist as well as a mycologist, so that one who studies his figures with a hand lens finds that he established an interpretation in his mind, then covered the paper with diagrammatic drawings that often tally with the idea more closely than with the material under his microscope. I am not undervaluing Brefeld as a pioneer. He did much, but as to details he left much undone, and we must not hesitate to correct mistakes incident to method and equipment.

There was a parallel development of mold culture in France in the laboratories of Raulin, van Tieghem, Bainier, Gueguen, and others. Both groups of pioneers tended to assume that every form found was new, that the number of species was small; hence fragmentary descriptions run from one line to ten in length, without enough comparative work among groups of congeneric species to develop the discrimination between fundamental and ephemeral characters.

EXPANDING THE DIAGNOSIS

Technological mycology, as far as molds are concerned, i.e., the controlled utilization of particular and definitely known molds in accomplishing biochemical processes, began to appear in the literature in the 1860's. By the 1890's, a number of such processes were fairly well recognized. Sopp and Wehmer, both students of Brefeld, made extensive studies of Penicillia and Aspergilli in connection with industrial problems. Again, the items included in an adequate description were greatly increased.

In this period (1860–1890) culture as a basis of description was deemed satisfactory if a colony was obtained by any procedure. Data from such a colony were regarded as information accessory to the study and description of natural masses presumed to be typical but were not included in diagnosis of the species. By 1890 some efforts were made to insure the purity of the colony. In the succeeding decade (1890 to 1900) species diagnoses based on colonies grown on laboratory media began to appear, limited to saprophytic molds. The substratum upon which the colony had been originally found continued to hold the key position as "habitat," which might mean much or nothing, according to the care with which the natural situation was studied and described. Many still consider designation of the place where the original specimen was obtained to be the only proper habitat to be cited. Unfortunately the habitat-substratum very commonly means only that the first gross inoculum was found there, not that the organism isolated was specifically active upon that substratum.

DEMANDS OF "APPLIED MYCOLOGY"

Thus far the methods and descriptive practices applicable to the molds used in industrial work were not differentiated from those of general mycology. The exacting demand for molds with specific adaptability to important biochemical uses began to be felt in the 1890's. Wehmer took out patents about 1893 for the manufacture of citric acid, using *Citromyces* as the fermenting agent. By 1905, he admitted that he thought at first that there were only two species, whereas he had now found that there were not less than six and he did not know which was which. Now we know there are many more.

Industrial use calls for exact information as to the biochemical possibilities of each mold. Culture media and conditions must be described with such definiteness that experimental work can be repeated and checked by analysis. Species must be described in terms sharp enough to insure identification.

Green Aspergilli are not adequately covered by the name *Aspergillus glaucus* nor all green Penicillia by *P. glaucum*. Means must be found to make species more tangible than rough aggregates held together by one or a few vague adjectives. The number of genera and species have increased beyond the wildest dreams of the early mycologists. In the effort to produce descriptions that will insure identification, species diagnoses have become progressively detailed and complicated. An extreme case may be cited: Strains of a great group were collected for many years. In working them over the monographer first developed punctilious notes as to the culture reactions of his whole series upon about half a dozen selected media. While making these notes, he preserved colonies of each species in alcohol. After the biochemical record was completed, a mount of each species was made with extreme care and a plate of drawings representing that species was prepared. When all the plates were finished, he prepared his Latin diagnoses by describing the structures and variations depicted in his plates! Then the accumulated mass of data was sorted out to species, pieced together, and published. This is one illustration in connection with a monograph, purely academic in character. In practical fact, there are many unrecognizable species among those described in detail within the last few years, and by all of us! WHY?

UNINTERPRETABLE DESCRIPTIONS

There are several reasons for failing to identify species from descriptions. There is little agreement as to just what characters are fundamental to genera and to species, and which are incidental variations representing direct response to environment. Great stress has has been put upon numbers and measurements of parts or details of branching systems. Large numbers of spores have been measured to the fraction of the micron, then the totals averaged or statistically analyzed to the fraction of a micron. As a result, emphasis upon unimportant details has often claimed the users' attention while the fundamental information escaped.

ESSENTIALS OF DIAGNOSIS

A safe description requires the exact identification of the culture substratum, of the biochemical effects of the culture upon that substratum, and correspondingly a series of observations of the organism itself upon that substratum.

Purity of culture is essential. The presence of bacteria, *Actinomycetes*, or other molds often alters colony characters. Different contaminants produce different alterations; hence entire elimination of other organisms is essential. Unfortunately, there are quite well-known laboratories from which cultures consistently show mites, as well as molds or bacteria. One is compelled to believe that some workers have never yet seen mites, recognized their ravages in culture, or distinguished the characteristic smell that usually betrays their presence.

More important yet, actual relations and sequences between cells are fundamental. New cells may be formed by fission: The older cell is cut into equal halves; or, they may bud out at one of a dozen places and in one of a dozen ways. Chains of spores may arise by budding so that the newest cells are always farthest from the basal cell or sporophore. Unbranched chains commonly arise from a basal cell—always showing the distal cell as the oldest while the newest cell is attached directly to the basal or sterigmatic cell. Again, this observation is fundamental.

A description of a ripe spore mass as a mass, or, pulled to pieces and the pieces described as found, may miss completely the significant facts. Whole series of descriptions that disregard cell succession in spore formation are simply uninterpretable, except in species in which satisfactory material was preserved or which have been found identifiable from some other line of observation.

Finally, details of cell wall structure (as Jeffrey said about paleobotanical specimens) may furnish as many real clews to relationship as the orthodox observation of sporogenous masses. Whole series of Aspergilli and Penicillia show such consistent markings of the stalk wall that examination of the sporophore wall with oil immersion objectives furnishes the most useful, most general, in fact, most easily determined series character.

But the nomenclatorial sins are not all chargeable to describers. The most striking lack among users of descriptive literature is in the appreciation of the cell relations involved in whatever structures they find. They fail to give proper consideration to cell contents, cell walls, their structure, color, and markings, to cell-succession in the formation of the sporogenous tissue seen under the microscope, and to the methods of aggregation of spores shown by heads, chains, or discharging mechanism. In other words, they fail to understand that identification of a mold is not accomplished by a superficial examination with a hand lens or with the low magnifications of the microscope. Exacting observation of the detail indicated in descriptive keys is ordinarily guided by those same keys. Failure to follow out definite instructions is hardly justifiable.

In the more complicated groups, it is not just matching a culture at a glance against a list of names, but the integration of all that one can learn by painstaking examination against the literature and investigations of perhaps 100 years. Into that investigation must go a first-hand knowledge of the life history of not one or two species but whole groups of species; it must include many years of observation in the field, controlled development in the culture room, and diligent reading in the library.

The need for care in establishing one's right to use generic and specific names can not be brushed away with a wave of the hand.

I sat beside a well-known worker not long ago and heard him tell an inquirer, "Why bother about the name--select one of them, go ahead and study your organism, and let future systematists decide where your organism belongs!" That dictum may suffice for some folks! But it creates chaos when the industrial or technological scientist makes the wrong selection and puts a series of industrial or biochemical papers about genus "X" and species "Y" into the literature when he actually worked with genus "A" and species "B." Indexed that way, an error is often cited many times as a fact by workers who have no means at hand to protect themselves. This is no hypothetical dilemma. I can name instances. Men regularly ask me for cultures based on such papers. Sometimes I can guess what they want; sometimes I have no idea why they make the request. Again I am sure they selected names at random.

In direct controversion of the dictum above, I believe it safe to say that a critical cultural and microscopical study of saprophytic molds will in the vast majority of cases throw together into homogeneous groups the things that eventually prove to belong together even though exact relations among them can not always be predicted from the hyphomycete stage.

To the industrial mycologist who is confronted by a mold isolated from where you please— important or merely questionable—the problem of what to call it is not theoretical, but practical. He should be able to examine the thing before him and reach some diagnostic characters that will lead to the correct literature of the species. In other words, however unimportant naming may be, as an end in itself, the descriptive and taxonomic problem must be solved before he can reach what his predecessors and perhaps his colleagues have written about the particular thing on the table.

If you are to do technical work with a particular mold, the fundamental dictum is: Know your organism by name and relationship, know it morphologically and physiologically, macroscopically and microscopically—know it so well that if anything goes wrong, you will detect the abnormality and correct it or make an adequate record. That applies whether you are a mycologist, a pathologist, a chemist, a physiologist, or any other brand of specialist; the man who fails to know his organism thoroughly is helpless before contamination, losses, or replacements, which often destroy the value of the results.

SUMMARY

I have tried to picture to you some of the problems of the "applied mycologist" who works with the so-called "common molds." As factors in human affairs, they spoil man's food, mildew his clothes, pollute his storerooms, and even attack his body. He gets some return by eating a few of them and using others in controlled fermentations of many kinds. He can not escape from them—he must live with them. The alternative, then, is to know them—individually, that he may use or combat the single species; as groups, that he may so compare and systematize his information that each item in it may contribute to arranged and ordered systems of knowledge. In a recent memorial to a great museum specialist, his services to mankind are listed as "(1) Scientific research, (2) Nomenclatural," etc. One makes bold to say that there is fully as much reasoning exhibited in comparing, reconstructing, and classifying a fossil as in digging it out of a hillside. The one dictum that must not be forgotten is that no single item has permanent value unless it represents the closest approximation to truth that can be reached by using all the means available. Any work, to be worth while, must be a rigorous search for truth. No bypath can be permitted to lure the worker aside for fancied results. If rigorous good faith in method, in performance and in interpretation are maintained, usefulness from the results can not possibly detract from the purity of the science. It is not the "pot of gold" that pollutes; it is the method of getting it. It is true in applied mycology as everywhere else that "He that entereth not by the door into the sheepfold, but climbeth up some other way, the same is a thief and a robber." If the solution of problems in human service makes our work applied science, then let us glory in the name.

CHEMISTRY.—*Anselme Payen, distinguished French chemist and pioneer investigator of the chemistry of lignin.*[1] MAX PHILLIPS, U. S. Bureau of Agricultural Chemistry and Engineering.

In these days when there is so much research activity on the chemistry and utilization of lignin and cellulose, it is fitting that we pause and pay our respects to the memory of a man who was a pioneer investigator of the chemistry of these two substances and who is now virtually forgotten. This man, Anselme Payen by name, published the results of his investigations on lignin and cellulose about 100 years ago. Although the percentage elementary composition of wood had previously been determined by Gay-Lussac and Thenard, Payen was the first one to attempt a separation of wood into its component parts. He treated wood with nitric acid and obtained a fibrous substance, which was relatively resistant to this reagent. This substance Payen called "cellulose," a term that he coined and introduced into chemical literature (Compt. Rend. Acad. Sci. Paris 8:51. 1839). He showed that cellulose had the same percentage composition as starch, and was apparently isomeric with it. He found that irrespective of its origin, cellulose had the same chemical composition, which could be represented by the formula $C_6H_{10}O_5$ and was apparently the identical substance in all plants. Payen also found that in isolating the cellulose he had to remove a substance or a group of substances, which had a higher percentage of carbon than cellulose. These substances Payen called "incrusting materials" ("*les matieres encrustantes*"), and he considered that the cellulose was mechanically incrusted or impregnated by them. These incrusting materials were later (1857) designated by Schulze as lignin, a term previously used by the botanist and plant physiologist de Candolle. The "incrustation hypothesis" of Payen was in the main supported by Schulze, although other investigators, among them Erdmann, opposed Payen's views. It is of interest, however, to point out that Payen's "incrustation hypothesis" has in more recent years been vigorously supported by Wislicenus and by Freudenberg.

Anselme Payen was born in Paris, France, on January 6, 1795. He was the son of Jean Baptiste Pierre Payen and Marie Françoise Jeanson de Courtenay. The elder Payen was educated at the Collége de Navarre in Paris, where he distinguished himself especially in philosophy and in the sciences. Through the insistence of his parents, how-

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[1] Read before the Division of History of Chemistry at the 98th meeting of the American Chemical Society held in Boston, Mass., September 11 to 15, 1939 Received December 11, 1939.

ever, he studied law and was for a time assistant to the procurator of the King for the city of Paris. This legal work, however, did not prove to his liking and in 1792 he established a factory at Grenelle, a suburb of Paris, for the production of various chemicals, chiefly sal ammoniac. This enterprise proved to be quite successful, and we soon find him engaged in the production of other chemical substances, such as sulphuric acid, hydrochloric acid, borax, refined sulphur, soda, and gelatin. He also established at Vaugirard a factory for the production of sugar from sugar beets. This was then a new industry in France, and during the continental blockade of the Napoleonic wars the cultivation of sugar beets and the extraction and refining of sugar therefrom were greatly encouraged by the French Government.

Anselme Payen received his early education from his father, who was a strict disciplinarian and very early inculcated in his son the habit of systematic study, a characteristic he retained for the rest of his life. However, in order to get a thorough grounding in the sciences his father sent him to the École Polytechnique in Paris where he studied chemistry under Vauqeulin, physics under Fourcroy, and mathematics under Trémery.

When young Payen was hardly 20 years of age his father placed him in charge of a plant for the refining of borax. This was then a relatively new industry in France for the Dutch virtually had a monopoly of the production of refined borax in Europe. The crude borax containing material was imported by the Dutch from the Orient and then refined by them. Young Payen conceived the idea of preparing borax synthetically from soda and boric acid, which was then obtained almost entirely from the hot springs and lakes of Tuscany. Payen's efforts were crowned with success, and in 1820 he placed on the market synthetic borax at one-third of the then prevailing price and thus succeeded in establishing a new industry in France.

In 1820 Payen's father died, and at the age of 25 years the young man had to assume full responsibility for the management of several factories established by his father, including the factory for the production of sugar from beets. For the clarification of the sugar solutions vegetable charcoal, principally wood charcoal, was employed. This peculiar property of wood charcoal was first brought to the attention of chemists in 1785 by an apothecary by the name of Lowitz of St. Petersburg, Russia, although according to E. O. von Lippmann the decolorizing property of wood charcoal was known as early as the fifteenth century to some of the German alum and saltpeter producers. However, this observation was apparently entirely forgotten. As already mentioned, among the chemicals made by Payen in his factory at Grenelle was sal ammoniac. This was prepared from the complex mixture of volatile substances obtained by the destructive distillation of bones and other products of animal origin. In the retort there remained a charred mass known as animal charcoal or bone char, which was then largely a useless by-product. Although Figuier of Montpellier in 1811 called attention to the decolorizing property of animal charcoal no application was made of this discovery until Payen got interested in this problem. Payen was motivated in this study by the double objective of improving the process of sugar refining, and of utilizing the animal charcoal. In a paper published in 1822, entitled "Theory of the Action of Animal Charcoal and Its Application to the Refining of Sugar," Payen gave results of a thorough study of the decolorizing properties of animal charcoal and pointed out that it owes its activity to the peculiar shape and state of aggregation of the carbon in this material. He also showed that it had the capacity of removing certain salts from solution and thus facilitated the crystallization of the sugar. He also developed an apparatus, called a "decolorimeter," for the determination of the decolorizing ability of various lots of animal charcoal. This may be considered the first important scientific paper published by Payen.

The credit for first using animal charcoal industrially for the refining of sugar clearly belongs to Payen. It was as a result of his zeal and industry that the popular prejudice against the application of animal charcoal to the refining of substances used for human consumption such as sirup and sugar was overcome. In addition to thus improving the process of sugar refining, Payen's work resulted in establishing an important new industry, namely, that of animal charcoal production. We thus see that a product which had heretofore been entirely useless became the basis of an important new industry. Few sugar technologists are today aware of the fact that when they decolorize their sugar solutions by means of animal charcoal they are making use of a method of sugar refining introduced more than a century ago by the French chemist Payen, now all but forgotten.

Because of his work on sugar beets, Payen very early in his life became interested in agricultural chemistry, and in the application of science in general to the improvement of agricultural practices, an interest he retained throughout his long and useful life. In these days when we hear so much about the industrial utilization of agricultural products, it may be of interest to point out that Payen more than 100 years ago not only advocated this very thing, but also made important contributions toward its realization. In a book he published in 1826 together with Chevalier, entitled "Traité de la Pomme de Terre" (Treatise on the Potato), he described in considerable detail not only the preparation of various foods and feeding stuffs for human and animal consumption, including the production of sugar and sirup, but also the methods for the preparation of starch and alcohol from potatoes. Part of the results contained in this book were published in the Proceedings of the Central Agricultural Society of France in the year 1823 and in recognition of this work Payen was given a gold medal by that society.

In the early part of the nineteenth century the need arose in France for the development of more economical methods of disposal of the carcasses of domestic animals that died of accident or of diseases of an epidemic character. Accordingly, in 1825 the Central Agricultural Society of France offered a first prize of 1000 francs for the most practical and economical method for the utilization of the carcasses of these animals. In 1830 the first prize was awarded to Payen for his 132-page memoir, which was published in the proceedings of the society for that year. There is a great deal of analytical data in this paper, which in many cases were obtained by methods devised by Payen. The method developed by him for the determination of nitrogen consisted in heating the sample to red heat and collecting the gaseous products in dilute sulphuric acid. While this did not, of course, give him all the nitrogen in the sample in the form of ammonia, it is nevertheless of interest from the historical standpoint as it was the forerunner of the Will and Varrentrapp method, where it is recalled the sample is heated with soda-lime and the ammonia collected. This was later superseded by the now well-known Kjeldahl method.

The methods that Payen described for the utilization in industry and in agriculture of various products of animal origin have proved to be practical, and many of the processes now in use for the utilization of the by-products of the meat-packing industry can be traced to those described by Payen in his paper published more than 100 years ago.

In 1835, at the age of 40, Payen gave up all active participation in the various manufacturing enterprises that he was interested in and accepted the position of professor of industrial and agricultural chemistry at the École Centrale des Arts et Manufactures in order that he might devote all his time to teaching and scientific research. In 1839 in addition to his duties at the École Centrale he also accepted the professorship of applied chemistry at the Conservatoire des Arts et

Métiers. These two positions he held until the time of his death.

The next 36 years of Payen's life were undoubtedly the most fruitful of his entire career, judged from the many contributions of a fundamental character he made to chemistry. He published about 200 scientific papers in various scientific journals such as the Comptes Rendus, Bulletin de la Société d'Encouragement pour l'Industrie National, Annales du Conservatoire des Arts et Métiers, Annals de Chimie et de Physique, Annales d'Histoire Naturelle, Bulletin de la Société Chimique, Journal de Chimie et Médecine, Mémoires de la Société Centrale d'Agriculture de France, Annals des Mines, and others. These papers covered a wide field of investigation and included such subjects as starch, dextrin, sugar, lignin, cellulose, bitumen, and various phases of agricultural chemistry including studies on plant and animal nutrition, the latter studies being conducted in cooperation with the famous agricultural chemist Boussingault. He also published papers in the field of inorganic chemistry. It was in connection with his studies on starch that Payen together with Persoz discovered the enzyme diastase. The paper on starch that he published in 1836 is remarkable for its clearness and precision. He showed that starches obtained from different sources differed as to size, shape, and state of aggregation, but that they all had the same chemical composition.

Payen had a practical turn of mind, and in the midst of his work on the purely scientific phases of chemistry he was always interested in the application of chemistry to industry, agriculture, hygiene, and medicine.

Payen was a prolific writer of books on industrial, agriculural, and food chemistry, and many of his books became standard works of reference and were translated into English and into several other European languages. Special mention should be made in this connection of his "Traité de Chimie Industrielle," in which Payen describes in great detail the various processes then used in chemical industry. Even the superficial reader of this book can see at once that its author was not a mere compiler, but rather one who has actually had many years of practical experience in the operation of the several processes described by him. In fact many of the processes there described were developed and improved by Payen. From the titles of the various books published by Payen one may get some idea of his extensive knowledge and interests.

The following is a list of his more important books (for a complete list of Payen's books the reader is referred to H. C. Bolton's "A Select Bibliography of Chemistry," Washington, 1893):

(1) Traité de la pomme de terre; sa culture, ses divers emplois dans les préparations alimentaires, les arts économiques, la fabrication du sirop, de l'eau-de-vie, de la potasse, etc Paris, 1826. (Published with Chevalier.)

(2) Traité de la fabrication et du raffinage des sucres. Paris, 1832

(3) Des engrais. Théorie actuelle de leur action sur les plantes principaux, moyens d'en obtenir le plus d'effet utile. Paris, 1839.

(4) Mémoire sur l'amidon, la dextrine et la diastase consideres sous les points de vue anatomique, chimique, et physiologique. Paris, 18—.

(5) Précis de chimie industrielle à l'usage des écoles préparatoires, aux professions industrielles, des fabricants et des agriculteurs. Paris, 1849.

(6) Précis d'agriculture théorique et pratique a l'usage des écoles d'agriculture, des propriétaires et des fermiers Paris, 1851. (Published with A. Richard.)

(7) Traité de la distillation des betteraves. Paris, 1854.

(8) Traité complet de la distillation des principales substances qui peuvent fournir de l'alcool; vins, grains, betteraves, fecule, tiges, fruits, racines, tubercules, bulbes, etc Paris, 1857.

(9) Précis théorique et pratique des substances alimentaires et des moyens de les améliorer, de les conserver et d'en reconnaitre les alterations, 4th ed., Paris, 1865.

According to Ostwald most great men can be divided into two classes. Those who in their youth, that is to say between 20 and 35 years of age, do their most outstanding work belong to the romantic type. Those who belong to the classical type are men who do outstanding work during their entire life. Payen clearly belonged to the latter class.

Payen was a member of many scientific societies. He was elected a member of the Central Agricultural Society of France (La Société Centrale d'Agriculture de France) in 1833 and was its permanent secretary for 26 years. He was elected a member of the French Academy of Sciences in 1842. Among the other societies to which he belonged may be mentioned l'Academie de Médecine, Société d'Encouragement pour l'Industrie Nationale, Société d'Horticulture de la Seine, and of the Council of Hygiene and Public Health.

Payen served the French Government in diverse capacities, particularly as a member of various governmental commissions. He was made a Knight of the Legion of Honor by Charles X in 1828. Louis Philippe made him an officer of the Legion of Honor in 1847, and in 1863 Napoleon III elevated him to the rank of commander.

One of the characteristics of Payen was his intense patriotism, and for 40 years he served as commander of the battalion of National Guard of the town of Grenelle, where he made his home.

In 1821 Payen married Zelie Charlotte Mélanie Thomas, which proved to be a very happy union. There were five children in the family, four of which, however, died in childhood and only one child, a daughter, survived him.

Payen's last days were greatly saddened by the disasters that France suffered as a result of the Franco-Prussian War. In spite of his advanced age he refused to leave the city of Paris on the approach of the Prussian army and displayed a great zeal in the study of all problems relating to the feeding of the besieged and famished city. On May 9, 1871, while attending one of the sessions of the Academy of Medicine he became ill and died three days later (May 12). Few of his friends and comrades were able to pay their last respects to this distinguished savant, for those were the days preceding the establishment of the Paris Commune and civil war raged on the streets of Paris. He was buried in the cemetery at Grenelle.

The biographic material contained in this paper was obtained from the following sources:

(1) Amer. Journ. Pharm. (ser. 4) 1: 432. 1871. (Anon. obituary notice.)

(2) Éloge biographique de M. Anselme Payen, by J. A. Barral, in Mémoires Publics par la Société Centrale d'Agriculture de France, pp. 67–87. 1873.

(3) Éloge de M. Payen, by Aimé Girard, in Annales du Conservatoire Imperial des Arts et Métiers 9: 317–331. 1873.

A complete list of the scientific papers published by Payen can be found in the Catalogue of Scientific Papers, compiled by the Royal Society of London.

BOTANY.—*Eight new species of* Pariana. JASON R. SWALLEN, U. S. Bureau of Plant Industry.[1]

Pariana is an anomalous genus of grasses that inhabits tropical forests and forest borders from Panama to Brazil and Peru. Because of the paucity of material in herbaria, the species have been considered as rare. The author, however, in 1933–34 observed these grasses growing rather commonly in northern Brazil, in places even completely covering the ground over rather large areas. The inflorescences are frequently entirely hidden by the foliage, which may account for the earlier collectors overlooking them. Tutin[2] recently revised the genus recognizing 23 species. Since then, one has been described from Ecuador by Pilger.[3] The eight species herein described bring the total number to 32.

Pariana nervata Swallen, sp. nov.

Perennis; culmi uniformes e rhizomatibus crassis erecti, 90–130 cm alti, vaginae inferiores internodiis longiores vel breviores laminis obsoletis, superiores internodiis multo longiores foliosae, auriculatae, sparse fimbriatae, glabrae vel sparse pilosae; ligula 3 mm longa, truncata; laminae 15–26 cm longae, 4–6 cm latae, acuminatae, infra scabrae, inflorescentia pendula, 20 cm longa, 1.3 cm lata; spiculae masculae 6.5–8 mm longae, pedicellis occultis, 3 mm longis minute pubescentibus; glumae 5–6 mm longae, 1.5–2.5 mm latae, 2–3-nerves, abrupte acutae, scaberulae, marginibus ciliatis; lemma 6.5–8 mm longum, 3.5–4 mm latum, 5-nerve, subobtusum, scabrum; spiculae femineae uniseriatae; glumae 8 mm longae, 3-nerves, acutae, scaberulae, reticulatae; fructus 6 mm longus apice scaber.

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[1] Received October 26, 1939.

[2] *Revision of the genus* Pariana. Journ. Linn. Soc. Bot. 50: 337–362. 1936.

[3] Notizbl. Bot. Gart. Berlin 14: 323. 1939.

Perennial, with leafy fertile culms; culms 90–130 cm tall, erect from rather short thick rhizomes; lower sheaths longer or shorter than the internodes, the blades obsolete, the upper blade-bearing ones much longer than the internodes, somewhat crowded, auriculate, sparsely fimbriate, glabrous or sparsely pilose; ligule 3 mm long, truncate; blades 15–26 cm long, 4–6 cm wide, acuminate, the lower surface scabrous, the upper glabrous; inflorescence drooping, 20 cm long, 1.3 cm thick; staminate spikelets 6.5–8 mm long, the pedicels hidden, 3 mm long, minutely pubescent; glumes 5–6 mm long, 1.5–2.5 mm wide, 2–3-nerved, abruptly acute, scaberulous, the margins ciliate; lemma 6.5–8 mm long, 3.5–4 mm wide, 5-nerved, subobtuse, scabrous; pistillate spikelets in one row; glumes 8 mm long, 3-nerved, acute, scaberulous, reticulate; fruit 6 mm long, scabrous at the apex.

Type in the U. S. National Herbarium, no. 1613658, collected at edge of forest, Mosqueira, near Belem, Para, Brazil, June 15, 1934, by Jason R. Swallen (no. 4873).

This species of *Pariana* differs from all the others in the conspicuously 5-nerved lemma of the staminate spikelets.

Pariana ovalifolia Swallen, sp. nov.

Perennis; culmi 135 cm alti, basi decumbentes, vaginae inferiores elongatae internodiis breviores laminis valde reductis, superiores internodiis multo longiores, glabrae, reticulatae, in ore sparse fimbriatae, ligula truncata 2–4 mm longa; laminae 17–24 cm longae, 6–7 cm latae, acuminatae, infra pubescentes, supra glabrae, petiolis 5–8 mm longis glabris; inflorescentia pendula, 16 cm longa; spiculae masculae pedicellis 3 mm longis, pubescentibus; glumae 2 mm longae, 1–2-nerves, acutae, pubescentes, marginibus ciliatis; lemma 5–6 mm longum, 2.5–3 mm latum, subobtusum, dense pubescens; spiculae femineae 7 mm longae; glumae aequales, 3-nerves, pubescentes; lemma 6 mm longum, acutum, glabrum apice pubescens.

Perennial; culms about 135 cm tall, erect from a decumbent base, the fertile one leafy toward the summit, bladeless below, glabrous; lower sheaths elongate, shorter than the internodes, the upper crowded, longer than the internodes, glabrous, reticulate-veined, occasionally bearing a few fimbriae at the mouth; ligule truncate, 2–4 mm long, blades 17–24 cm long, 6–7 cm wide, the two uppermost reduced, narrowed toward the base, acuminate, glaucous and pubescent on the lower surface, green and glabrous on the upper, the petiole 5–8 mm long; inflorescence slender, drooping, 16 cm long, the whorls of spikelets distant, not overlapping in the lower part, gradually becoming more crowded toward the summit, but the staminate florets never obscuring the pedicels of the staminate spikelets in the next higher whorl; staminate spikelets 5–6 mm long, the pedicels 3 mm long, pubescent, especially at the base and on the margins; glumes 2 mm long, 1 mm broad at the base, 1 or sometimes 2-nerved, acute, more or less pubescent, the margins ciliate; lemma 5–6 mm long, 2.5–3 mm wide, subobtuse, densely pubescent; fertile spikelet 7 mm long; glumes thin, equal, 3-nerved, pubescent; lemma 6 mm long, acute, pubescent toward the tip, otherwise glabrous

Type in the U. S. National Herbarium, no. 1614216, collected in forest borders 35 kms north of Monte Alegre, Pará, Brazil, January 28–February 1, 1934, by Jason R Swallen (no. 3379).

Pariana ovalifolium belongs to the *Foliosae* group in which the fertile culms are leafy. It is most closely related to *P. lunata* Nees, which is a much smaller plant, about half as high, with smaller lanceolate rather than oval blades, which are broad and rounded at the base.

Pariana aurita Swallen, sp. nov.

Perennis; culmi biformes, erecti vel basi decumbentes. Culmi steriles ad 80 cm alti in parte superiore foliosi, scabri, vaginae inferiores internodiis multo breviores, superiores internodiis multo longiores, carinatae, auriculatae; ligula 8–15 mm longa; laminae 15–28 cm longae, 3.5–5.8 cm latae, acuminatae vel subattenuatae, glabrae vel scaberulae, petiolis crassis, 7–10 mm longis, pubescentibus. Culmi fertiles graciles, 50 cm alti, glabri; vaginae internodiis longiores laminis obsoletis; ligula curta; inflorescentia 12 cm longa, gracilis, pendula; spiculae masculae 4 mm longae, pedicellis 2–4 mm longis, pubescentibus vel pilosis, marginibus ciliatis; glumae 2.5–3 mm longae, angustae, acuminatae, 1–2-nerves; lemma 4 mm longum, 1.5 mm latum, reticulatum, scaberulum, antherae ±12, lineares, 2.5 mm longae; spiculae femineae biseriatae 6 mm longae; glumae 1-nerves, acutae, pubescentes, marginibus ciliatis, lemma 5 mm longum, apice minute pubescens

Perennial, culms erect or somewhat decumbent at the base. Sterile culms 80 cm tall, leafy in the upper fourth; lower sheaths bladeless, much shorter than the internodes, rounded on the back, the upper ones crowded, much longer than the internodes, distinctly keeled, glabrous; ligule 8–15 mm long, joined at the base with the conspicuous auricles of the sheaths; blades 15–28 cm long, long-acuminate, narrowed toward the base, glabrous or scaberulous; fertile culms 50 cm tall, the bladeless sheaths mostly longer than the internodes, rounded on the back, glabrous; ligule very short or wanting; inflorescence drooping, 12 cm long, the whorls of spikelets scarcely overlapping; staminate spikelets 4 mm long, the pedicels conspicuous, 2–4 mm long, sometimes fused toward the base, pubescent or pilose, the margins ciliate; glumes 2.5–3 mm long, usually 1 or sometimes 2-nerved, acuminate, rather narrow at the base, glabrous or minutely pubescent, the margins very shortly ciliate; lemma 4 mm long, 1.5 mm wide, finely reticulate-veined, scaberulous; anthers ±12, linear, 2.5 mm long; pistillate spikelet 6 mm long, the glumes acute, 1-nerved, pubescent, narrower than the mature fruit; fruit 5 mm long, the lemma minutely pubescent near the tip and on the lateral nerves

Type in the U. S. National Herbarium, no. 1539376 collected in dense forest at the mouth of the Rio Santiago, above Pongo de Manseriche, Department Loreto, Peru, November 17, 1931, by Ynes Mexía (no 6116).

P. aurita is a very striking species, which is probably most closely related to *P. gracilis* Doell, resembling it in the slender inflorescence of rather distant whorls of spikelets. However, *P. gracilis* has fewer, much smaller blades 10–15 cm long, and a ligule only 2–2.5 mm long.

Pariana distans Swallen, sp. nov.

Perennis; culmi difformes e rhizomatibus erecti, scabri. Culmi steriles 40 cm alti in parte superiore foliosi; vaginae inferiores laminis obsoletis inter-

nodiis breviores, superiores internodiis longiores, pubescentes; ligula truncata, 2 mm longa, pubescens; laminae 10–15 cm longae, 1.8–2.5 cm latae, lanceolatae, acuminatae, infra scaberulae supra pubescentes Culmi fertiles 40 cm alti, infra inflorescentiam dense pubescentes; vaginae internodiis longiores, glabrae, laminis obsoletis; inflorescentia 9 5 cm longa, erecta, verticillis spicularum remotis; spiculae masculae 7 mm longae pedicellis 3 mm longis, dense pubescentibus; glumae 4–5 mm longae, 3-nerves, scabrae, marginibus ciliatis; lemma 7 mm longum, 2.5 mm latum, pubescens; spiculae femineae incognitae.

Perennial; culms numerous, erect from rhizomes, about 40 cm tall, scabrous Sterile culms leafy toward the summit, the lower sheaths bladeless; lowermost sheaths short, longer than the internodes, the one of the midculm elongate, shorter than the internode, the upper bladebearing sheaths again longer than the internodes, glabrous or minutely pubescent; ligule truncate, about 2 mm long, pubescent; blades oblong-lanceolate, 10–15 cm long, 1 8–2 5 cm wide, acuminate, shortly soft pubescent on the lower surface, scaberulous above, the petiole 2 mm long, pubescent Fertile culms densely pubescent below the inflorescence; sheaths all longer than the internodes, bladeless, the uppermost one elongate, glabrous; inflorescence 9.4 cm long, erect, the whorls of spikelets rather distant, the staminate florets scarcely reaching the base of the pedicels of the staminate spikelets of the whorl above; pedicels of the staminate spikelets 3 mm long, densely pubescent, more or less fused together; glumes 4–5 mm long, 3-nerved, acute, scabrous, the margins shortly ciliate, lemma 7 mm long, 2.5 mm wide pubescent; pistillate spikelet undeveloped.

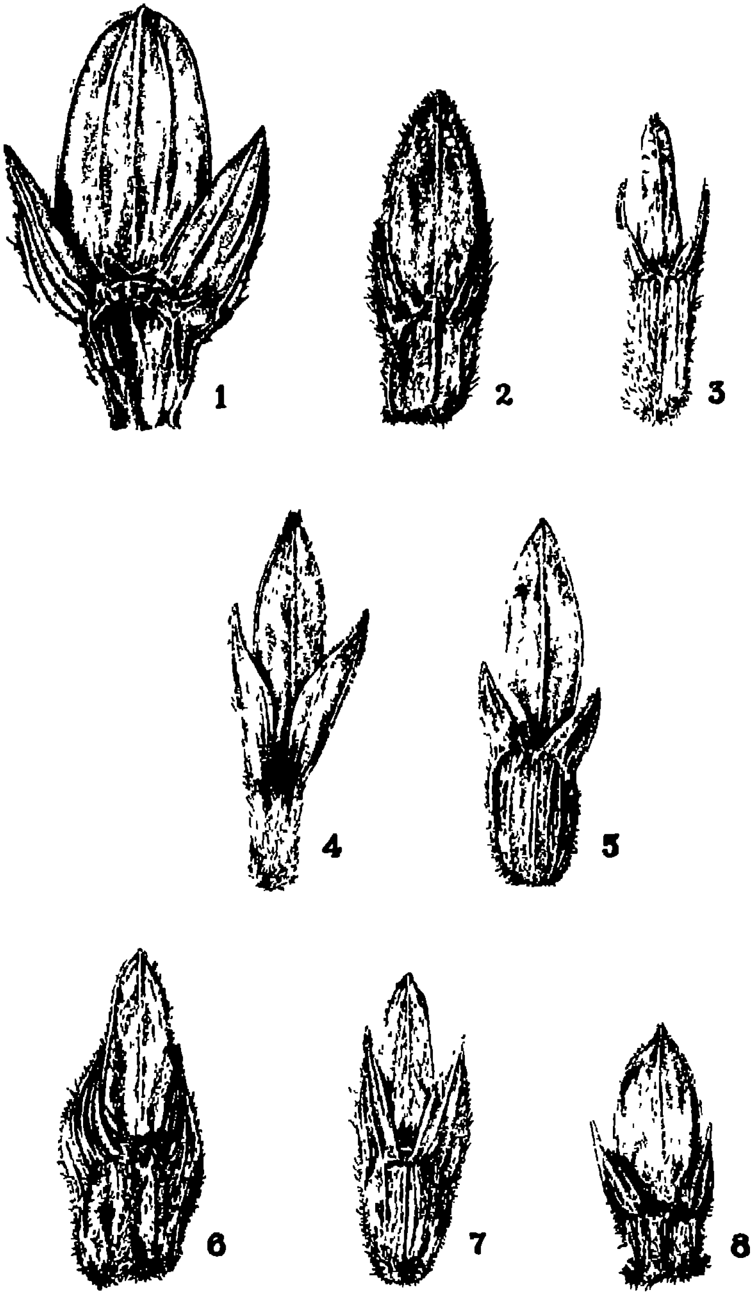
Type in the U. S. National Herbarium, no. 1614187, collected in forest borders, Santarem, Pará, Brazil, January 19–26, 1934, by Jason R. Swallen (no. 3286)

This species differs from all the others in the *Graciles* group in the 3-nerved glumes of the staminate spikelets and the longer staminate lemma In the other species of this group the glumes of the staminate spikelets are only 1-nerved (rarely 2-nerved), and the lemmas are not more than 5.5–6 mm long

Pariana ligulata Swallen, sp nov.

Perennis; culmi difformes caespitosi, erecti, basi decumbentes Culmi steriles 70–95 cm alti, in parte superiore foliosi; vaginae inferiores internodiis breviores laminis obsoletis, superiores internodiis multi longiores, carinatae; ligula 6–10 mm longa, firma, obtusa vel truncata; laminae 15–32 cm longae, 3–4 cm latae, subattenuatae, reticulatae, petiolis crassis, 6–10 mm longis glabris vel minute pubescentibus Culmi fertiles 50–60 cm alti, laminis obsoletis; vaginae internodiis longiores; inflorescentia 12 cm longa, pendula, parte inferiore in vagina suprema inclusa, verticillis spicularum approximatis; spiculae masculae 5–6 mm longae, pedicellis 4–5 mm longis sparse pubescentibus; glumae 1 5–2 mm longae, 1–2-nerves, triangulae, acutae, scabrae; lemma 5–6 mm longum, 2–2 5 mm latum, 3-nerve, acutum, reticulatum, scabrum; antherae lineares, 3 mm longae; spiculae femineae 9 mm longae; glumae 1–3-nerves acutae vel subacuminatae, scabrae; lemma 7 mm longum, acutum, subapiculatum.

Perennial; culms in rather large spreading clumps, erect from a decumbent base. Sterile culms 70–95 cm tall, leafy in the upper half; sheaths elongate, the lower ones a little shorter than the internodes, the upper ones longer than the internodes but scarcely crowded, keeled toward the summit,



Figs. 1–8.—Front view of staminate spikelets of new species of *Pariana*, showing the pedicel, glumes, and lemma, ×5: 1, *P. nervata*; 2, *P. ovalifolia*; 3, *P. aurita*; 4, *P. distans*; 5, *P. ligulata*; 6, *P. sociata*; 7, *P. modesta*; 8, *P. velutina*. All drawings made from the type specimens by Mrs. Frances C. Weintraub.

reticulate-veined; ligule 6–10 mm long, firm, obtuse or truncate; blades 15–32 cm long, 3–4 cm wide, more or less plaited, the transverse veins conspicuous on the lower surface, acuminate, narrowly rounded at the base, glabrous on both surfaces; petiole 6–10 cm long, glabrous or minutely pubescent. Fertile culms 50–60 cm tall, nearly hidden under the foliage of the sterile culms; sheaths somewhat inflated, all longer than the internodes, bladeless or sometimes with blades 1–2.5 cm long, inflorescence drooping, about 12 cm long, the whorls of spikelets distant, scarcely overlapping; staminate spikelets 5–6 mm long, the pedicels 4–5 mm long, sparingly pubescent, glumes 1.5–2 mm long, triangular, acute, 1 or sometimes 2-nerved, scabrous, lemma 5–6 mm long, 2.5 mm wide, strongly 3-nerved, reticulate-veined above, scabrous; anthers about 3 mm long; fertile spikelet 9 mm long, the glumes 1-nerved, scabrous or pubescent at the base; fruit 7 mm long, abruptly acute, almost apiculate.

Type in the U. S. National Herbarium, no. 1613673, collected in forest at Boa Vista, Rio Tapajos, Pará, Brazil, January 7–13, 1934, by Jason R. Swallen (no. 3177).

P. ligulata differs from all other species in the *Graciles* group in the large pistillate spikelets and the long comparatively narrow plaited blades.

Pariana sociata Swallen, sp. nov.

Perennis. Culmi difformes e rhizomatibus erecti vel basi decumbentes. Culmi steriles ±40 cm alti, glabri, in parte superiore foliosi, vaginae glabrae vel in parte superiore pubescentes, inferiores internodiis multo breviores, superiores internodiis multo longiores in ore dense fimbriatae pilis 10–15 mm longis; laminae 8.5–11 cm longae, 1.7–2.7 cm latae, acuminatae, infra minute pubescentes, supra scaberulae, marginibus serratis; ligula truncata 1 mm longa. Culmi fertiles 30 cm alti, vaginae internodiis longiores, inflatae, glabrae vel minute pubescentes, in ore dense fimbriatae, laminis obsoletis vel ad 2 cm longis; inflorescentia 7–8 cm longa, 1–1.3 cm lata, erecta, verticillis spicularum approximatis; spiculae masculae 5 mm longae, pedicellis 4 mm longis dense pubescentibus; glumae 2–3 mm longae, 1–3-nerves, acuminatae, pubescentes, marginibus ciliatis; lemma 5 mm longum, 2.5–3 mm latum, acutum, dense pubescens; antherae ±8, lineares, 2 mm longae; spiculae femineae uniseriatae, 6 mm longae; glumae acutae, 3-nerves, aequales, pubescentes; lemma 5 mm longum, 3 mm latum, acutum, glabrum.

Perennial; culms erect from a more or less decumbent rhizomatous base, glabrous. Sterile culms leafy toward the summit, about 40 cm tall; lower sheaths much shorter than the internodes, bladeless or the blades much reduced, the upper ones crowded, keeled at least toward the summit, densely fimbriate in the mouth, the hairs 10–15 mm long; ligule truncate, 0.5 mm long; blades 8.5 cm long, 1.7–2.7 cm wide, rather abruptly acuminate, rounded at the base, minutely pubescent on the lower surface, scaberulous above, the margins finely but distinctly serrate, the petiole about 1 mm long, pubescent. Fertile culms about 30 cm tall; sheaths inflated, all longer than the internodes, bladeless or sometimes the blade as much as 2 cm long, 1 cm wide, sparsely to rather densely fimbriate at the mouth; inflorescence 7–8 cm long, 1–1.3 cm wide, stiffly erect, the staminate spikelets about half overlapping the pedicels of the staminate spikelets in the whorl above; staminate spikelets 5 mm long, somewhat spreading; pedicels 4 mm long, densely pubescent; glumes 2–3 mm long, 1–3-nerved, acuminate, pubescent, the margins ciliate; lemma 5 mm long, 2.5–3 mm wide, short but densely pubescent; anthers 2 mm long, pistillate spikelet 6 mm long, the glumes acute, 3-nerved, pubescent; fruit 5 mm long, 3 mm wide, acute, glabrous.

Type in the U. S. National Herbarium, no. 1613672 collected in open sandy forest between Caxias and Barra do Corda, Maranhão, Brasil, February 18–26, 1934, by Jason R. Swallen (no. 3599).

P. sociata is similar in appearance to *P. zingiberina* Doell, which differs in having thicker, shorter blades, almost no fimbriae at the mouth of the sheaths, and smaller glabrous staminate spikelets.

Pariana modesta Swallen, sp. nov.

Perennis; culmi difformes, graciles e rhizomatibus erecti. Culmi steriles 15–35 cm alti, in parte superiore foliosi; vaginae glabrae, inferiores internodiis breviores, superiores internodiis multo longiores in ore fimbriatae; laminae 3–7.6 cm longae, 5–14 mm latae, lanceolatae, minute pubescentes. Culmi fertiles 20 cm alti; vaginae internodiis breviores inflatae, glabrae vel minute pubescentes, laminis obsoletis; inflorescentia 3–4 cm longa, erecta, verticillis spicularum approximatis; spiculae masculae 5 mm longae, pedicellis 4 mm longis; glumae 3–4 mm longae, 3-nerves acutae vel subacuminatae basi latae, pubescentes, marginibus ciliatis; lemma 4.5–5 mm longum, 2 mm latum, 3-nerve, acutum, scaberulum vel pubescens; palea acuta lemma aequans; antherae ±20, 1–1.5 mm longae; spiculae femineae 6 mm longae; glumae aequales, 1–3-nerves, acuminatae, pubescentes; lemma 5 mm longum, acutum.

Perennial, culms slender, erect from rhizomes. Sterile culms 15–35 cm tall, leafy toward the summit, glabrous; lower sheaths much shorter than the internodes, the upper ones crowded, much longer than the internodes, conspicuously fimbriate at the mouth; ligule very short, thick; blades 3–7.6 cm long, 5–14 mm wide, thin, lanceolate, minutely pubescent on both surfaces, the pubescence sometimes obscure. Fertile culms 20 cm tall, glabrous or minutely pubescent; sheaths all shorter than the internodes, inflated, bladeless, never fimbriate; inflorescence 3–4 cm long, bearing 3 or 4 rather distant whorls of spikelets, the whorls scarcely overlapping exposing the pedicels of the staminate spikelets; staminate spikelets 5 mm long, the pedicels 4 mm long, densely pubescent toward the base becoming nearly glabrous at the summit; glumes 3–4 mm long, strongly 3-nerved, acute or subacuminate, broad at the base, more or less pubescent, the margins ciliate; lemma 4.5–5 mm long, 2 mm wide, 3-nerved, abruptly acute, scaberulous and more or less pubescent; palea acute, equaling or slightly exceeding the lemma; anthers about 20, 1–1.5 mm long; pistillate spikelet 6 mm long, the glumes equal, acuminate, 1–3-nerved, pubescent, the lemma 5 mm long, acute, rather broad, almost entirely enclosing the palea.

Type in the U. S. National Herbarium, no. 1613666, collected in high open forest between Caxias and Barra do Corda, Maranhão, Brazil, February 18–26, 1934, by Jason R. Swallen (no. 3544).

In the region where the type was collected, this species was very abundant, in some cases being the dominant herbaceous plant in moist open woods called "Carasco." The fertile culms were never plainly evident being obscured under the foliage of the sterile culms, the young ones even hidden in the ground cover of old leaves. Only a small proportion of the plants had fertile culms at the time the specimens were collected.

DISTRIBUTION: Open forests, east-central Maranhão, Brasil. Between Caxias and Barra do Corda, *Swallen* 3597, 3544 (type); Barra do Corda to Grajahu, *Swallen* 3631; Carolina to San Antonio de Balsas, *Swallen* 4132.

This species was found growing with *P. sociata* and resembles it in several ways, especially in having thin blades, numerous fimbriae, and a short erect inflorescence. It differs, however, in being a much smaller plant with short narrow blades, short slender inflorescences of distant whorls of smaller glabrous staminate florets, the glumes of which are very broad at the base, strongly 3–5-nerved.

Pariana velutina Swallen, sp. nov.

Perennis; culmi difformes basi adscendentes. Culmi steriles 45–50 cm longi infra nodos dense pubescentes; vaginae inferiores obsoletae, mediae elongatae internodiis breviores laminis obsoletis, superiores foliatae internodiis multo longiores, auriculatae, fimbriatae, carina dense pubescente, laminae 12–16 cm longae, 2–4.6 cm latae, lanceolatae vel ovato-lanceolatae, acuminatae, infra dense pubescentes, supra glabrae nervo medio dense hirtello. Culmi fertiles graciles, 25 cm longi, infra inflorescentiam dense pubescentes, vaginae 2 vel 3, internodiis breviores, inflatae, glabrae; alaminis obsoletis; inflorescentia erecta 6 cm longa, spiculae masculae 4.5 mm longae, pedicellis occultis 2–2.5 mm longis pilosis basi villosis; glumae 2–2.5 mm longae, 1 mm latae, 1–2-nerves, acutae vel acuminatae, scabrae, lemma 4.5 mm longum, 1.5–2 mm latum, 3-nerve, acutum, scabrum, basi pubescens; antherae 2.5 mm longae; spiculae femineae uniseriatae; glumae 5 mm longae, 1–3-nerves, acutae vel subobtusae, pubescentes; fructus 5 mm longus, 3 mm latus, glaber, superne pubescens.

Perennial; culms biform, erect from an ascending base. Sterile culms 45–50 cm long, densely pubescent below the nodes; lowest sheaths obsolete, the median one elongate, shorter than the internodes, the blades obsolete, the upper leaf-bearing ones crowded, much longer than the internodes, auriculate, fimbriate, densely pubescent on the keel; blades 12–16 cm long, 2–4.6 cm wide, lanceolate or ovate-lanceolate, acuminate, softly pubescent on the lower surface, glabrous on the upper surface, the midnerve densely hirtellous. Fertile culms slender, 25 cm long, densely pubescent below the inflorescence; sheaths 2 or 3, shorter than the internodes, inflated, glabrous, the blades obsolete; inflorescence erect, 6 cm long; staminate spikelets 4.5 mm long, the pedicels hidden, 2–2.5 mm long, pilose, densely villous at the base, glumes 2–2.5 mm long, 1 mm wide, 1–2-nerved, acute or acuminate, scabrous, lemma 4.5 mm long, 1.5–2 mm wide, 3-nerved, acute, scabrous, pubescent toward the base; anthers 2.5 mm long; pistillate spikelets in one row; glumes 5 mm long, 1–3-nerved, acute or subobtuse, pubescent; fruit 5 mm long, 3 mm wide, glabrous, pubescent toward the summit.

Type in the U. S. National Herbarium, no. 1458908, collected at Gamitanacocha, Río Mazán, Department Loreto, Peru, altitude 100–125 meters, by Jose M. Schunke (no. 164).

Pariana trichosticha Tutin is the only other species that has the midnerve of the blades hirtellous on the upper side but differs from *P. velutina* in having glabrous blades, densely pubescent sheaths, and longer glumes on the pistillate spikelet (7 mm long), which extend beyond the fruit.

BOTANY.—*New varieties and new combinations in the genera* Clausena, Oxanthera, *and* Triphasia *of the orange subfamily, Aurantioideae.*[1] WALTER T. SWINGLE, U. S. Bureau of Plant Industry.

In connection with the preparation of a synopsis of the orange subfamily, soon to be published, I have brought to light a number of new genera, species, and varieties. I have already published a paper on my new taxonomic arrangement of the subfamily.[2]

I have had the good fortune to be able to borrow from several of the great herbaria of Europe, Asia, and the United States a large number of specimens of the species of *Clausena* and of other genera of the subfamily Aurantioideae. Thanks to the use on a large scale of the modified Juel method[3] of restoring herbarium material of flowers, young fruits, etc., and making serial microtome sections of them, I have been able, with the skilled help of Dr. Albert H. Tillson, to throw new light on some of the taxonomic problems that have arisen in separating the numerous and often highly variable species of some of the genera of this subfamily.

Genus CLAUSENA Burm.

Clausena luxurians (Kurz) Swingle, comb nov.

Clausena Wallichii Oliv. var *luxurians* Kurz, Journ Asiat Soc Bengal **44** (2): 133. 1876.

Clausena Wallichii affinis sed differt (1) foliis multo grandioribus, (2) foliolis grandioribus et multo paucioribus, (3) floribus minoribus, (4) partes florales sine cellulis residuiis tanniniferis repletis, (5) alis petiolis duplo latioribus, (6) marginis foliorum integris vel leviter crenulatis nec denticulatis, (7) foliolis in sicco pallido-viridis, nec fusco-viridis.

A small, meagre shrub, leaves large, 33-50 by 20–27 cm, 5–7- (often 6-) foliolate, leaflets lanceolate or broadly oval, variable in size, lower lateral leaflets 6.5–7.5 by 4–5 cm, upper lateral and terminal leaflets 15–21 by 6.5–9.5 cm, larger leaflets acuminate or broad-acuminate at the apex, variably cuneate at base and decurrent into the petiolules, lateral veins variable in prominence, larger ones few, 7–9, arising at angles of 70-75° with the midrib, the intermediate, fainter and shorter ones often arising at greater angles (80–89°!), margins entire or slightly crenulate; rachis narrowly winged, wings 0.8–1.5 mm wide on each side of the rachis; inflorescences terminal, paniculate, flowers small, 4–5 mm in diameter, 4-(or 5-?) merous, borne on short pedicels, 1–2 mm long with minute ciliate bracts at the base, calyx lobes acute, with a large oil gland at the tip (not seen in Fig. 1 but visible in other sections on the same slide), anthers with a small oil gland in the connective, pistil (including gynophore) 2.5–2.8 mm long, ovary 1–1.1 mm long,

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[1] Received January 6, 1940

[2] SWINGLE, WALTER T *A new taxonomic arrangement of the orange subfamily, Aurantioideae*. Journ. Washington Acad. Sci. 28: 530–533. 1938.

[3] See SWINGLE, WALTER T *New methods utilized in studying the taxonomy of the orange subfamily* Journ. Washington Acad Sci 29: 270. 1939.

1–1.3 wide, with one medium-sized protuberant oil gland at the tip of each locule, style 1.3 mm long, cylindrical, 0.5–0.6 mm in diameter, except at the base, which is 0.3 mm in diameter, where it joins the ovary; stigma not delimited from the style; fruits (immature) globose, 5–6 mm in diameter.

Type specimen.—Burma, rare in eastern slopes of Pegu Yomah in tropical forests, *Sulpiz Kurz* 1995, flowering branches, Herb. Roy. Bot. Gard. Calcutta; photographs and serial sections, S & T Nos. 519 A, slides 1–4 (168 cross sections of a flower bud), 519 B 1, and 519 C 1 (95 longitudinal sections of 2 pistils), Herb. National Arboretum.

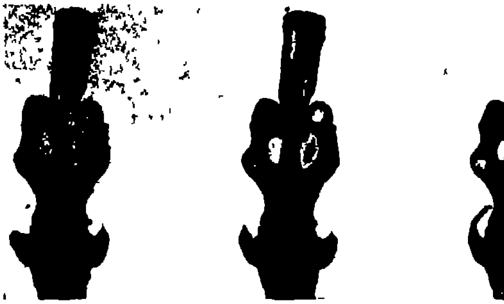

Fig. 1.—*Clausena luxurians* Serial longitudinal sections of pistil of type specimen. ×10

Cotype specimen.—Same locality, *Kurz* 1995, "Choungmerah Chg.," Herb. Roy. Bot. Gard. Calcutta, photographs and serial microtome sections, S & T. Nos. 520 A, slides 1–4 (198 cross sections of 1 flower bud), 520 B 1, 520 C 1 (76 longitudinal sections of pedicel, calyx, and pistil), Herb. National Arboretum.

Remarks.—The original description of *Clausena Wallichii* var. *luxurians* by Kurz is very short; it reads, in full: "*Clausena Wallichii* Oliv. Var. β *luxurians*, rachis leafy-winged; leaflets only 4–2 pairs with an odd one, 4–8 in. long, remaining green in a dried state."

The leaves of this species differ markedly from those of *C. Wallichii* in having much larger, broader, and fewer leaflets (5–7 instead of 13–17!) On the other hand, the flowers of *C. Wallichii* (which has much smaller leaflets) are decidedly larger, the pistil being from one-fifth to one-quarter longer and the style nearly two-thirds longer!

Another species, *C. Guillauminii*, native to French Indochina, resembles *C. luxurians* and *C. Wallichii* in having leaves with narrowly winged rachis and also has flower parts not greatly different from those of *C. Wallichii*; it is, however, strikingly different from both of them in having dimorphic oil glands in the leaves, many very small ones, and a few very large ones, ¼ to ½ mm in diameter, clear bright red by transmitted light. These three species are doubtless descended from a common ancestral form but have diverged so much in taxonomic characters that they are now good, easily distinguishable species.

One of the most striking characters of *C. luxurians*, in which it differs markedly from all species at all closely related to it, is the almost complete absence in the flower parts of tissue cells filled with brownish, nearly opaque tannin residues that occur in abundance in all the other species of *Clausena* except *C. suffruticosa*, a very aberrant species; *C. dentata* var. *longipes* has such cells but only a few of them; note the contrast between Figs. 1 and 2 in this respect.

C luxurians in its general aspect, flower morphology, and especially in its leaf characters, somewhat resembles *C. heptaphylla* of British India, Burma, Indochina, and Malaya, but the leaves of this latter species do not have a winged or margined rachis and have floral organs with abundant cells filled with tannin residues. The many-sided affinities of this newly recognized species are characteristic of the situation found among the many closely related species of this large genus.

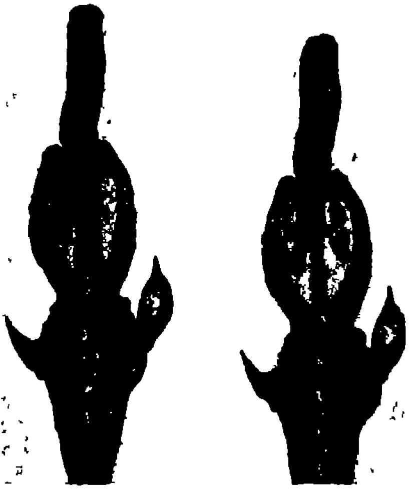

Fig 2.—*Clausena Wallichii* Serial longitudinal sections of pistil *Burkill* 30288, Amherst Distr Burma, Herb Bot Gard Calcutta ×10.

Clausena dentata var. **Henryi** Swingle, var. nov.

A typo differt (1) fructu ovoideo nec sphaerico, nigro, (2) foliis foliolisque duplo majoribus hirsutioribus, (3) petalis hirsutis, (4) foliolis lateralibus superioribus saepe grandioribus quam folioli terminales

Type specimen—China, Ichang, *Henry* 4122, flowering branch, May 1888, Herb. Kew Gardens; photograph and serial microtome sections, S. & T Nos. 528 A, slides 1–3; 528 B, slides 1–3 (381 cross sections of flower bud); 528 C 1 and D 1 (85 longitudinal sections of two pistils); Herb National Arboretum.

Cotype specimen 1—China, Ichang, *Henry* 3127, February 1887, fruiting branch, Herb. Kew Gardens; photograph Herb. National Arboretum.

Cotype specimen 2.—China, Ichang, *Henry* 13028, Herb. Kew Gardens; photograph and serial microtome sections, S & T. No. 538 A, slides 1–3, B 1–3. (336 cross sections from 2 flower buds); C 1, D 1 (105 longitudinal sections from 2 flower buds); Herb. National Arboretum.

Serial microtome sections made from a flower bud of the type specimen (*Henry* 4122) show the flowers to be tetramerous; the anthers show small oil glands in the connective, obscured by dense tannin residues in the surrounding cells; total length of pistil from calyx to tip of stigma 4–4½ mm, gynophore hourglass-shaped, 0 6–0.7 mm high, ovary 1–1.2 mm high, 1.1–1.3 mm wide, with a minute, slightly protuberant oil gland at the top of each locule, style 1.2–1.3 mm long, subclavate, 0.5–0.6 mm wide at base where it joins the ovary, gradually expanding toward the tip where it is 0.7–0.8 mm wide; stigma not clearly delimited.

Remarks —This striking variety of *C. dentata* (Willd.) Roemer has been identified wrongly as *C. suffruticosa* (Roxb.) Wight, which is a very different plant which has been confused with Henry's *Clausena* doubtless because of its rather slender ovoid fruits The fruits of *C. dentata* var. *henryi*, 9–12 by 6–8 mm, black when ripe and said to be edible, are very different from the fruits of the typical *C dentata* of British India, which when ripe are globose, whitish green, and about 8–12 mm in diameter. Henry's *Clausena* has the northernmost range yet reported for any species of the genus. It grows near Ichang, Hupeh Province, China, about latitude 31° N. Many varieties of *C. dentata* have been described, but most of them are still inadequately known. Another Chinese variety of this species, *C. dentata* var. *robusta* Tanaka, is a vigorous plant having rather small globose fruits, 7–8 mm in diameter.

Still another Chinese variety very inadequately described and named by Léveillé as a distinct species, *C. Dunniana* Lev., can better be considered a variety of *C. dentata*.

Clausena dentata var. Dunniana (Lev.) Swingle, comb. nov.

Clausena Dunniana Léveillé, in Fedde's Report. **10**: 67. 1912.

Type specimen —Pin-fa, Kweichow Province, China, *J. Cavalerie* 1072, Herbarium of Edinburgh University; photograph in Herb. National Arboretum

Cotype specimen 1 —Same locality, *J Cavalerie* 1072, June 18, 1903, flowering branch, Herb. Kew Gardens

Cotype specimen 2 —Same locality, *J. Cavalerie* 1072, flowering branch, Herb Univ Edinburgh; photograph and fragments ex Herb Monseigneur Léveillé, in Herb Arnold Arboretum

This plant is still very little known, as Léveillé's description was very short. It looks much like some specimens assigned to *Clausena dentata* var *robusta* Tanaka, and more study is needed to separate these two poorly characterized varieties Some specimens of *C. dentata* var. *Dunniana* have petiolules 4–6, rarely 8, mm long, longer than have been seen on any other Chinese forms of *C dentata*

Clausena brevistyla var. halmaheirae (Miq) Swingle, comb. nov.

Clausena halmaheirae Miquel, Ann Mus. Bot. Lugd.-Bat. 1: 211. 1863.

This variety has diminutive pistils, only 1.4–1 5 mm long, with the gynophore only 0.2–0 3 mm long, the ovary 0 8 mm long and 0.8 mm wide, rough with oil glands, the style 0.5–0 6 mm long and cylindrical The inflorescences are large, 25–35 cm long, with widely spreading primary branches and sturdy terminal pedicels, 2–4 mm long.

The above measurements were taken from serial microtome sections made from a topotype specimen from Halmaheira Island (*Teysmann* 5667) in Herb. Roy. Bot. Garden Calcutta

The styles are slightly longer than those of *C. brevistyla* but otherwise similar.

The southernmost species of *Clausena*, *C. brevistyla* Oliver, native to northeastern Australia, has, as its name indicates, a very short style, less than one-half as long as the ovary. It now appears that a species described from Halmaheira (or Gilolo) Island in the Moluccas, *C. halmaheirae* Miq., also has a very short style and doubtless belongs close to *C. brevistyla* and can best be made a variety of it.

Genus OXANTHERA Montr.

Oxanthera is a genus of the *Wenzelia* group of the subtribe Triphasiinae, tribe Citreae. It is limited to New Caledonia and with the species here transferred to the genus has four species with large orangelike flowers but with no pulp-vesicles in the fruit. This excludes them not only from the genus *Citrus* but from the whole subtribe Citrinae.

Oxanthera undulata (Guill.) Swingle, comb. nov.

Citrus undulata Guillaumin, Bull Soc Bot. France **85**: 304. 1938

This species has thin leaves unlike the other three, which have thick, more or less coriaceous leaves. This seems to indicate they are more or less pronounced xerophytes, whereas *C undulata* is more likely a mesophyte.

All the species of this very curious genus are discussed in some detail in my synopsis of *Citrus* and related genera of the orange subfamily, now in press.

Genus TRIPHASIA Lour.

The genus *Triphasia* is a small one that has been known to botanists for several centuries and is the type of the subtribe Triphasiinae of the tribe Citreae. The best-known species is *Triphasia trifolia* with trifoliate leaves, small white flowers, and tiny red berries, often grown in hothouses and in subtropical gardens as an ornamental plant.

Recently an autotetraploid form of this species was discovered in the U S. Bureau of Plant Industry citrus greenhouse.

Triphasia trifolia var **tetraploidea** Swingle, var. nov.

A typo differt (1) chromosomatis duplo numerosioribus in omnibus cellulis (autotetraploideis), (2) foliis paulo crassioribus, floribus paulo grandioribus.

Type specimen.—Washington, D C , citrus greenhouses, U S Bureau of Plant Industry, *Swingle* C P B No 2889, P.E.I 27778, fruiting branch, S & T. No 575, slide 1, numerous pollen mother cells showing tetraploid chromosomes, made by Dr A. E Longley, March 3, 1937, Herb National Arboretum, No 70839

Remarks.—This variety differs from the species in having larger flower parts and thicker leaves, and especially in having 36 chromosomes in all the somatic cells instead of 18, the normal number for almost all the plants of this orange subfamily so far studied.

This autotetraploid form of the common trifoliate limeberry looks much like tetraploid forms of *Citrus*, having, like them, thicker leaves and larger flower parts. Longley,[4] who has studied the chromosome numbers of *Citrus* and many related genera, first detected the tetraploid nature of this plant. This variety doubtless originated as a mutation from the common diploid form of the species. This tetraploid form of the common limeberry is a vigorous plant that flowers and fruits freely in the greenhouse. It may prove to have value in ornamental plantings both in the hothouse and in subtropical gardens.

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[4] LONGLEY, ALBERT E. *Polycarpy, polyspory, and polyploidy in citrus and citrus relatives* Journ Washington Acad Sci **15**: 347–351, 1 fig 1925.

ZOOLOGY.—*A new pycnogonid from Pescadero, Calif., and distributional notes on other species.*[1] JOEL W. HEDGPETH. (Communicated by WALDO L. SCHMITT.)

The pebble beach near Pescadero, Calif., is not a good collecting ground for marine invertebrates, since the reef is somewhat like a sea wall, but it is the only habitat so far known of a hitherto undescribed species of *Ammothea.* A specimen of this pycnogonid was collected in September 1930, and when the beach was revisited in August 1939 three more specimens were taken from the same small area of the reef at the south side of the pebble beach cove. The recent collection was made from worn eelgrass holdfasts just below the *Littorina scutulata* horizon at a 2.8 tide (about the upper limit of zone 3 of the classification of Ricketts and Calvin, 1939), which is a rather high distribution for littoral pycnogonids on the California coast and supports Giltay (1934) in his contention that the genus *Ammothea* is composed of littoral forms adapted to various biotopes and that a large number of species are still to be discovered in regions not yet carefully investigated for pycnogonids.

Ammothea euchelata, n. sp. Fig 1

Holotype—Male, with egg clusters. Pescadero, Calif, August 15, 1939. U S.N.M. no. 78411

Paratypes.—One male, in U.S.N.M. collections; egg-bearing male, dissected, in author's collection.

Description—Body circular, about 1 5 mm in diameter, lateral processes contiguous but not fused, with low tubercles on the anterior and posterior distal corners of the processes Proboscis ovoid, directed ventrally, not quite so long as trunk. Eye tubercle near anterior border of first trunk segment, low and without spines or projections; eyes large and distinct. Abdomen moderately long, about twice the length of the lateral processes of the last pair of legs, with a few small spines near the apex Chelifores nearly as long as the proboscis although apparently a little over half as long; scape stout, little more than half the length of the chelifore; chelae well developed, subglobular, the fingers broadly curved so that only the tips oppose, without teeth or setae Palpus slightly longer than proboscis, first joint short, about equal to third joint; second joint slightly longer than first and third combined; fourth joint about equal to second, last four joints short, more or less equal, together a little longer than the fourth; joints 5, 6, and 7 with ventral processes, terminal joint oval, a few setae on the ventral processes and on the distal portion of the terminal joint. Oviger of male about twice as long as palpus, first joint short, stout; second joint three times as long as wide; third joint slightly longer than second but half the diameter; joints 4 and 5 equal, shorter than the third; joint 6 one-half as long as 5, joints 5 and 6 with spines on outer margin directed backward; joints 7, 8, and 9 nearly equal, 7 and 8 stout, 9 slender; terminal joint short and blunt. The last four segments of the oviger bear a spine with teeth on its inner

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[1] Received September 20, 1939.

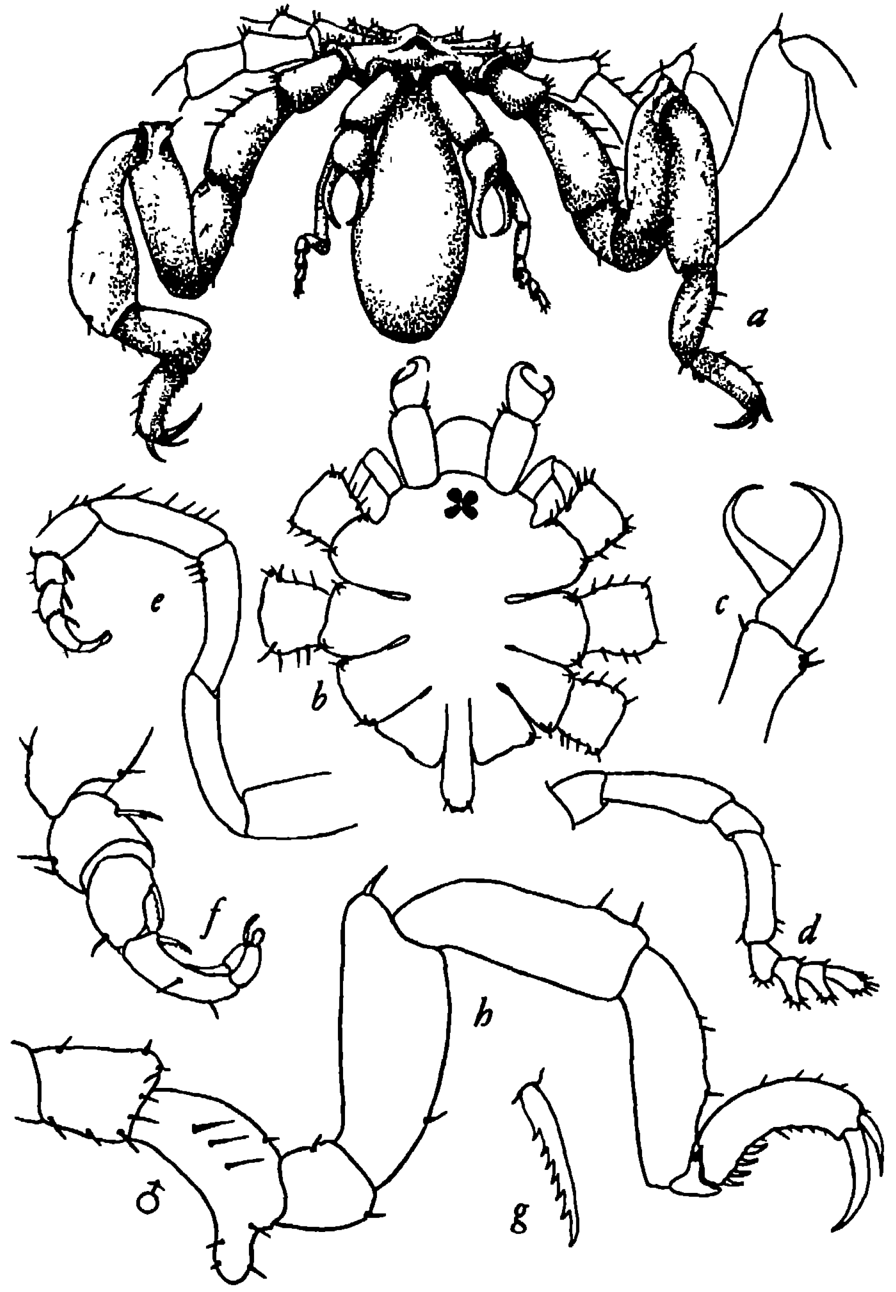

Fig 1.—*Ammothea euchelata*, n sp.: *a*, Front view of holotype, ×30; *b*, dorsal view of trunk of holotype, ×30; *c*, ventral view of right chelifore of paratype, ×45; *d*, right palpus of paratype, ×45; *e*, right oviger of paratype, ×45; *f*, detail of terminal joints of oviger, ×120; *g*, denticulate spine from oviger, ×1,000; *h*, right third leg of paratype, ×33 (All drawings made with the aid of a camera lucida; magnifications approximate.)

margin at the ventral base of the joint. In the terminal segment this spine is sickle-shaped, situated near the distal ventral margin, and on the slide mount obscures a minutely lobed leaflike terminal spine In Fig. 1, *f*, this spine has been drawn away to reveal the structure of the terminal spine. Eggs about 0.1 mm in diameter, in small scattered masses of 12–20 along the oviger. Legs stout, comparatively short; first and second coxal joints armed with spines laterally; genital protuberance of second coxa of male very conspicuous; third coxa and remainder of leg with a few scattered spines. Tarsus curved, terminal claw strong, nearly as long as tarsus, auxiliary claws about half as long as terminal claw. Proportions of the joints in millimeters approximately as follows: 0.5, 0.5, 0 5, 1.0, 1.0, 0 8, 0.25, 0.5 Measurements (approximate) as follows:

	Holotype	*Paratype* (from dissected parts)
Body	1.5 mm	1.5 mm
Proboscis	1.25	1.0
Abdomen	—	0.6
Chelifore	1.0	1.0 (scape 0.6, chela 0.4)
Palpus .	—	1.5
Oviger	—	2.0
Third leg	2.5 (from above, unextended)	5.0 (sum of segments)

Relationships.—No other species of *Ammothea* known to me has such large and well-developed chelae in the adult as *A euchelata*, and this character separates it from the rest of the California species, in which the chelae are rudimentary knobs in the adult. The ventral protuberances of the terminal segments of the palpus are similar to those of *Ammothea pribilofensis* Cole, which has a higher, pointed eye tubercle and a broader, blunter proboscis than *A. euchelata*. Denticulate spines occur only on joint 10 of the male oviger of *A pribilofensis*. *Ammothea euchelata* is evidently related to *A. spinosa* (Wilson), in which the chelifores are sometimes chelate They are much smaller, however, and the legs as a whole are spinier. The terminal joints of the palpus of *Ammothea spinosa* do not have the ventral projections of *A. euchelata*, and the denticulate spines of the oviger are symmetrical and the proportions of the joints themselves different in *A spinosa* [2]

Distribution —Although I have collected intensively for pycnogonids at various reefs along the central California coast from Marin County to Pacific Grove, I have so far collected this species only at Pescadero. On September 30, 1930, one egg-bearing male was collected from *Bugula* along with a specimen of *Ammothea gracilipes*, apparently the southern record for the latter, which is most abundant just north of the Golden Gate

DISTRIBUTION NOTES

Moss Beach, San Mateo County, Calif.—*Ammothella tuberculata* Cole, five specimens, from eelgrass holdfasts and among hydroids on pitted rocks, 2–11–34. *Lecythorhynchus marginatus* Cole, four specimens, 4–23–32; 12 specimens, including egg-bearing males, on *Abietinaria*, 2–10–34; six specimens, 11–6–38. *Tanystylum intermedium* Cole, three specimens, 2–10–34; three specimens, on *Abietinaria*, 11–6–38. *Phoxichilidium femoratum* (Rathke), 10 specimens, including egg-bearing males, 4–23–32; three specimens, 2–10–34 *Pycnogonum stearnsi* Ives, one female, under rock, 3–26–32.

Muir Beach, Marin County, Calif.—*Ammothea gracilipes* Cole, 12 specimens, including egg-bearing males, from *Bugula*, *Abietinaria*, and pitted rocks, 5–11–33. *Ammothella tuberculata* Cole, one specimen, 5–23–32; three

[2] *Ammothea acheloides* Wilson (Pl. 5, Fig 1) = *A spinosa*, auctoritate Schimkewitsch.

specimens, 5–11–33; one specimen, April 1934 *Lecythorhynchus marginatus* Cole, 12 specimens, including egg-bearing males, from *Abietinaria*, 5–11–33; 12 specimens, including egg-bearing males, from *Abietinaria*, April 1934 *Tanystylum intermedium* Cole, 14 specimens, including egg-bearing males, from *Abietinaria*, April 1934. *Pycnogonum stearnsi* Ives, three males from *Abietinaria*, April 1934.

Jenner, Sonoma County, Calif (near Bodega Bay).—*Ammothea gracilipes* Cole, one female, and *Pycnogonum stearnsi* Ives, one female, both from *Campanularia*, collected by A R. Grant, February 1934

It will be noted in the Moss Beach collections that in 1932 *Phoxichilidium femoratum* was common and *Lecythorhynchus marginatus* was scarce, but that the situation was reversed in 1934. Unfortunately it was not possible to make regular collections to determine if this is a case of periodicity or simple coincidence. At Muir Beach, *Lecythorhynchus marginatus* and *Tanystylum intermedium* were collected from the same fronds of *Abietinaria* in equal numbers. These two species and *Pycnogonum stearnsi* occur in the *Abietinaria* along the sheltered rock wall at the north border of the beach, while *Ammothea gracilipes* occurs in hydroids and bryozoan colonies among the maze of large boulders that marks the south border of the Muir Beach cove There is some variation in the length of the protuberance on the dorsal part of the second coxal joint in this species, in some specimens being as long or longer than the coxal segment There was no variation observed in the direction of increased body size and reduction of these protuberances as described by Lozina-Lozinsky (1933) in his variety *borealis* of *Ammothea gracilipes* from the Gulf of Kastri

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ZOOLOGY.—*A new trematode from* Siren lacertina: Diplostomulum sirenis, *n. sp.*[1] George C. Kent, Jr., Vanderbilt University. (Communicated by Paul Bartsch.)

A number of *Siren lacertina* (Linnaeus), collected from marshes along the banks of the Cumberland River, near Nashville, Tenn., in October 1938, were kept in an aquarium until May 1939, when the animals were sacrificed for routine histological examination. Of four specimens examined (all that were available), three (length approximately 25 cm) were found to be infected with a trematode, herein described as a new species of the genus *Diplostomulum*. Over 100 specimens were obtained from one host, 50 from a second, 6 days

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[1] Received October 27, 1939.

later, and 30 from a third, 13 days after the first animal was sacrificed. The fourth animal (14 cm) did not appear to be infected. The Diplostomula were not encysted but were free in the pericardial cavity, where they were clumped in a white mass about the ventricle. Inspection of the alimentary tract and of the great vessels revealed no similar forms in these organs.

Materials and methods.—The parasites were collected with a pen point previously dipped in black India ink on which background the white specimens were easily visible, and with which instrument they were more easily separated from the slimy exudate than would have been possible with a pipette. They were transferred to a watch glass containing physiological saline at room temperature. Specimens to be permanently mounted were fixed with acetic-sublimate, or formalin-alcohol-acetic acid. For staining, Harris's hematoxylin, borax-carmine, and hematoxylin and eosin were employed in various dilutions, and for periods of 10 minutes to 48 hours. When necessary, acid alcohol was used for destaining. Undiluted Harris's hematoxylin applied 10 minutes gave the most satisfactory differentiation.

Diplostomulum sirenis, n. sp.

Description.—General form and anatomy typical. Forebody and hindbody distinct. Forebody in living specimens thin, foliaceous, elongated, slightly concave ventrally, which concavity is retained in many preserved, unmounted specimens. Hindbody short, located posterodorsally on forebody. Oral sucker terminal, mouth ventroterminal. Acetabulum situated anteriorly in posterior half of body, circular in outline in living specimens, transversely elongated in stained mounts as result of longitudinal contraction of entire body.

Hold-fast organ prominent in stained specimens. Lateral suckers short, broad prominences in living and preserved specimens.

Pharynx long, prepharynx short, esophagus longer than prepharynx. Caeca slim, containing, in living, active forms, a dark, granular substance, which is moved slowly backward and forward in the caeca as if by peristaltic waves, and from the presence of which the dilation of the posterior termination of the caeca may be observed.

Fundament of reproductive system a darkly staining, single or irregularly lobulated mass, situated in midline at posteriormost extremity of forebody in preserved specimens.

Urinary bladder occupies greater part of hindbody, with pair of saclike anterior diverticula terminating as separate lobes at a body level immediately posterior to hold-fast organ. In stained sections these appear as isolated vesicles occupying a position between the hold-fast organ and the reproductive fundament. Two or three diverticula also extend laterad from the urinary bladder. Bladders discharge through a short, common duct and dorsoterminal pore, which contracts and relaxes rhythmically. Anteriorly, the urinary bladder proper communicates on either side with the lateral tubular portion of the reserve bladder. The remaining reserve bladder system is essentially the same as described by Hughes (1929). Numerous short branches of the common collecting trunks, and of their tributaries, end as blind, ellipsoidal vesicles containing, in living and in certain preserved specimens, an ellipsoidal, highly refractile calcareous concretion. Flame cells appear in pairs.

Living specimens average 0.825 mm extended, without pressure. Measurements on 16 specimens mounted in toto are given in Table 1. The 16 specimens were chosen at random from those subjected to one of each of the different fixatives and stains employed.

Table 1.—Measurements (in Millimeters) of 16 Mounted Specimens of *Diplostomulum sirenis*

Measurement	Minimum	Maximum	Average
Body:			
Length	0.370	0.577	0.482
Width	0.192	0.281	0.243
Oral sucker:			
Length	0.044	0.061	0.051
Width	0.037	0.047	0.042
Pharynx:			
Length	0.024	0.051	0.041
Width	0.013	0.029	0.021
Acetabulum:			
Length	0.034	0.062	0.048
Width	0.047	0.078	0.065
Hold-fast organ:			
Length	0.068	0.119	0.092
Width	0.047	0.081	0.070

Behavior.—In physiological saline, the animals move by attaching the oral sucker to the substrate and contracting the body. The ventral sucker next becomes attached, the oral sucker relaxes, and the anterior portion of the body stretches forward. Progress is slow. When suspended in the liquid, the movements differ in that the posterior portions of the body are alternately flexed on the sides of the body, and extended, without progress forward in space. Light from beneath results in writhing movements.

Host.—*Siren lacertina* (Linnaeus).

Habitat.—Pericardial cavity, in masses attached near ventricle.

Locality.—Marshes of Cumberland River, near Nashville, Tenn.

Type specimen.—U. S. N. M. Helm. Coll. no. 9284, mounted in toto.

Discussion.—The method and duration of fixation and staining have far-reaching effects on the size and appearance of the mounted specimen, especially in the relative size of individual structures. Lateral suckers may, in the same species, be either inverted as cuplike depressions, or extended as protuberances. The acetabulum becomes elongated transversely. The hindbody especially becomes contracted, and the urinary bladder occupies an abnormal position in stained specimens. Therefore, great care should be exercised in the setting up of new species on the basis of minor measurement differentials, the condition of the lateral suckers, or of other superficial characters, in stained mounts. Partially to offset these variations, the measurements in Table 1 were made on specimens subjected to one of each of the several different techniques employed in this study.

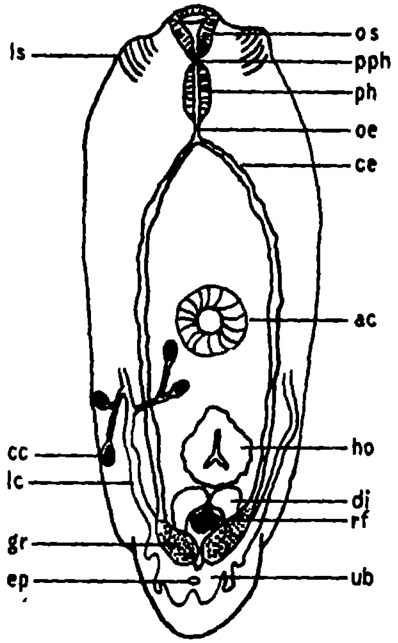

Fig 1 — *Diplostomulum sirenis*, n sp

ac	Acetabulum
cc	Calcareous corpuscle
ce	Caecum
di	Bladder diverticulum.
ep	Excretory pore
gr	Granular material in caecum
ho	Hold-fast organ
lc	Lateral collecting vessel
ls	Lateral sucker
oe	Esophagus
os	Oral sucker.
ph	Pharynx
pph	Prepharynx
rf	Reproductive fundament
ub	Urinary bladder

D sirenis resembles five other forms found in North America [*D. browni* Hughes (1929), *D gigas* Hughes and Berkhout (1929), *D. huronense* (La Rue), described by Hughes and Hall (1929), *D. trituri* Kelley (1934), and *D. ambystomae*, described by Rankin and Hughes (1937)]. *D. sirenis* differs from *D. browni* and *D. huronense* in being larger; from *D. ambystomae* in being consistently smaller in the stained condition, and longer in living specimens, body extended, without pressure It most nearly approaches *D gigas* in relative size of structures, stained. *D. sirenis* differs from all these species in the presence of paired, anterior diverticula of the urinary bladder, which lie just posterior to the hold-fast organ. In this respect it resembles *D trituri* but differs from the latter in relative measurements, which, as pointed out above, should not constitute the sole basis for introducing a new species. The most notable difference in these two forms is the presence of an additional series of conspicuous outpocketings of the reserve bladder in *D. trituri*, resulting in a condition of complexity of this apparatus. Two or three similar outpocketings only are found in *D. sirenis*, and these are confined to the urinary bladder proper. *D. sirenis* is, therefore, intermediate in complexity of the reserve bladder system between *D. gigas*, which is without outpocketings, and *D. trituri*, which has many.

Finally, it is probable that the occurrence of *D. sirenis* in the pericardial cavity of *Siren* is a physiological character of specific importance, since *Triturus viridescens* spends four years strictly on land (Reinke and Chadwick, 1939), while *Siren lacertina* evidently remains, except for short excursions in underground burrows, in water where its food supply exists, and in which medium it may best respire.

Whether the hosts were infected before being placed in captivity is problematical. Three large Sirens, examined several months previously, did not appear to be infected. Opportunities were offered for infection at intervals during the latter two months of captivity, when snails and insect larvae were transferred to the aquarium from marshes where *Siren* are known to exist. Since the latter have not been observed to eat snails, infection may have arisen from one of at least two possible sources: (1) From the insect larvae, by ingestion; (2) from the snails, by swimming of the cercaria in the water, and entrance into the host via the skin (which is very thick), or via the gills or pharynx. Until *D. sirenis* may be isolated from the blood stream it seems logical to assume that the metacercaria found in the pericardial cavity probably are transmitted to the succeeding host when *Siren* is eaten by another vertebrate. Since the latter is often prey to snakes, the final host may therefore be a reptile, although the possibility of *Siren* being devoured by a bird may also exist.

A study of the life history of each of these closely related forms is indicated, to ascertain their exact taxonomic relationships.

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Obituary

Waldemar Lindgren, professor emeritus of geology at the Massachusetts Institute of Technology, died on November 3, 1939. He was born at Kalmar, Sweden, on February 14, 1860. He became interested in geology and mining at an early age and in 1882 was graduated from the Mining Academy at Freiberg, Germany, with the degree of Mining Engineer. In 1884 he began work with the United States Geological Survey, with which he maintained connection for 31 years. In 1905 he was made chief of the Division of Mineral Resources of the Geological Survey, in 1908 was placed in charge of the Section of Metalliferous Deposits, and in 1911 was appointed Chief Geologist of the Survey. In 1912 he was appointed William Barton Rogers Professor of Economic Geology, and head of the Department of Geology, at the Massachusetts Institute of Technology His book "Mineral Deposits," the first edition of which appeared in 1913, became the leading text and reference on this subject throughout the world Other publications include about 185 titles

While chairman of the Division of Geology and Geography of the National Research Council (1927–28) Dr Lindgren established the Annotated Bibliography of Economic Geology, to which he contributed (with a reading knowledge of at least eight languages) about 2,500 abstracts in a 10-year period He was one of the founders of the Journal of Economic Geology (1905 and served as associate editor.

Dr. Lindgren received many honors in recognition of his achievements. Princeton (1916) and Harvard (1935) conferred honorary degrees, and the Society of Economic Geologists, l'Association des Ingénieurs de Liége, the Geological Society of America, and the Geological Society of London awarded him their medals. The American Institute of Mining and Metallurgical Engineers issued in tribute to him the Lindgren Volume on Ore Deposits of the Western States (1933) He was chosen honorary chairman of the Sixteenth International Geologic Congress held in the United States in 1933.

Dr. Lindgren held membership in the Washington Academy of Sciences, the National Academy of Sciences, the American Philosophical Society, the American Association for the Advancement of Science, the American Institute of Mining and Metallurgical Engineers (honorary life member), the Mining and Metallurgical Society of America (president, 1920), the Geological Society of America (president, 1924), the Society of Economic Geologists (president, 1922), the Geological Society of Washington, and the Geological Society of Boston. He was a foreign member of the Royal Academy of Sciences of Sweden, the Academy of Engineering of Sweden, the Geological Society of London, and the Academy of Sciences of Leningrad. He was a corresponding member of the Canadian Institute of Mining and Metallurgy and the Geological Society of Stockholm and an honorary member of the Geological Society of Belgium

In 1886 Dr. Lindgren married Ottolina Allstrin of Gothenburg, Sweden, who died in 1929. Lindgren's stimulating and forceful influence on geologic thought is tempered to all who knew him personally by his sympathetic consideration to the viewpoints of others and his kindly and unemotional manner in objections. He possessed an engaging personality and keen sense of humor, and together with his great capacity for accomplishment in his vocation he maintained broad interests in history, art, languages, and world politics.

JOURNAL
OF THE
WASHINGTON ACADEMY OF SCIENCES

VOL. 30 MARCH 15, 1940 No. 3

GEOLOGY.—*Placer gold in Alaska.*[1] J. B. MERTIE, JR., U. S. Geological Survey.

The study of metalliferous placers, if pursued in its many aspects, is a very comprehensive one, because it leads directly into several branches of geology and indirectly into the fields of mineralogy, metallography, inorganic and physical chemistry and allied topics. A lode of some sort must necessarily have existed before a placer could be formed. Therefore the local bedrock geology is of primary interest, and its investigation calls for petrographic work and possibly the study of ore deposits. But usually neither the rocks nor the ores now exposed at the surface are exactly like those that existed at the time when the placers were formed, so that an understanding of surficial geologic processes is also required not merely to interpret the preexisting bedrock geology, but more particularly to decipher the history and mode of accumulation of the placers. Yet physiography and the related surficial earth sciences do not always suffice, because the metals contained in many placers were liberated from their bedrock sources long before the present surficial features originated. Hence stratigraphy and paleontology not infrequently constitute another part of the investigation. It is hardly necessary to add that structural geology is likewise an essential topic, because the structure of bedrock is an important factor in all geomorphic interpretations. And finally, certain of the more specialized branches of geology and geophysics may enter into the investigation.

By these remarks it is not intended to imply that the writer has made any such comprehensive studies. Unfortunately many reasons exist why the gold placers of Alaska have not received such treatment, and not the least of these is that the time allocated to such work, both in the field and in the office, has been inadequate for investigations of such an extended scope. Nevertheless, even casual field examination and limited laboratory work, when extended over a considerable period of years, lead to the formulation of more or less definite ideas; and, though such ideas merely point the way toward future investigations, they may be worthy of statement.

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[1] Address of the retiring president of the Geological Society of Washington, delivered December 13, 1939. Published by permission of the Director, Geological Survey, United States Department of the Interior. Received January 12, 1940.

PHYSICAL AND CHEMICAL PROPERTIES OF GOLD-SILVER ALLOYS

The physical and chemical data presented below are in no sense intended to be a compendium of the mineralogy, physics, and chemistry of gold and silver, as an ordinary volume would not suffice to cover such a vast field. Instead there will be given certain disconnected but significant data that seem to bear upon the origin and accumulation of placer gold.

Pure gold has not been found in nature. Instead, it is always alloyed with more or less silver, together with a small proportion of base metals, mainly copper and iron, which collectively are designated as the dross. Gold has been found alloyed with some of the platinum metals; and other specialized species, such as alloys of gold and bismuth, and natural amalgam have also been described. The purest free gold that I have been able to find any record of is a sample of lode gold from the Great Boulder Mine, in the Kalgoorlie district of Western Australia, which had a fineness of 999 1 parts gold in a thousand; but several samples from the Cripple Creek district are recorded as having finenesses of 999. Most of the Australian gold is exceptionally high grade, yet the quartz veins of the Wiluna area, of Western Australia, have produced the lowest grade of natural gold on record, ranging in fineness from 400 to 580 parts gold in a thousand, the remainder being mainly silver Native silver is relatively uncommon,

TABLE 1.—FINENESS OF PLACER GOLD IN ALASKA

Fineness (parts gold per thousand)	Number of samples	Fineness (parts gold per thousand)	Number of samples
975–965	4	795–785	27
965–955	13	785–775	28
955–945	33	775–765	21
945–935	6	765–755	17
935–925	16	755–745	12
925–915	47	745–735	4
915–905	115	735–725	9
905–895	122	725–715	6
895–885	127	715–705	1
885–875	104	705–695	2
875–865	119	695–685	0
865–855	166	685–675	1
855–845	125	675–665	1
845–835	101	665–655	0
835–825	143	655–645	0
825–815	79	645–635	1
815–805	37	635–625	1
805–795	39	625–615	1

and is usually free of gold. The placer gold so far mined in Alaska ranges in fineness from 620 to 973 parts gold in a thousand. Philip S. Smith[2] has recently compiled from the files of the U. S. Geological Survey 1,528 assays of the placer gold alloys that have been mined in Alaska. Seven additional assays, showing finenesses of less than 620, are also on record from the Territory, but these are considered probably to represent bullion that included man-made impurities such as lead shot, solder, and other such materials. This record is presented in Table 1.

The above data are also presented in the form of a frequency curve in Fig. 1. The graph was prepared by C. E. Van Orstrand and H. C. Spicer, both of the U. S. Geological Survey The following statement, prepared by Mr. Van Orstrand, gives the essential facts bearing upon the choice of an interpolation formula, and a summary of the computations.

The equation, $y = ax^m e^{-bx^n}(b_0 + b_1x + b_2x^2)$ (1)
is here used primarily as an interpolation formula. In this equation, x represents the series of integers, 1,2,3, . . . beginning with 1 at 970.

The equation, $y = ax^m e^{-bx^n}$ (2)
has been used to represent production curves in the oilfields expressed as a function of the time[3] Calculation of the coefficients in (1) has been made by first evaluating the constants in (2) and then multiplying the computed values of (2) by $(b_0 + b_1x + b_2x^2)$ and solving the product relation equated to the observed values of y for the values of b_0, b_1, and b_2 All the adjustments were made by the method of least squares.

The results of the calculations show that the sum of the observed values (Σy_0) is 1,524; that of the computed values (Σy_c) is 1,493. The sum of the squares of the residuals (Σv^2) is 8,423. The first two quantities can be brought into closer agreement, and the last one can be reduced somewhat by making a more precise determination of n The modal frequency is $x = 11.11$, or, in terms of fineness, 868 9. The computations involved in obtaining this graph were performed by Mr Spicer

The histogram shown in Fig. 1 may possibly suggest to the reader that a less regular curve is justified by the numerical data. But the 1,528 assays, upon which this figure is based, are in reality only a small part of the thousands of assays known to have been made upon the placer golds of Alaska. Hence the irregularity of the histogram is interpreted as a condition due entirely to imperfect sampling, and not to any physical-chemical relationship that might be shown in an equilibrium diagram. For this reason, a probability curve is believed to be the best method of representing the available data.

[2] SMITH, PHILIP S. *Fineness of gold from Alaska placers.* U S Geol. Surv Bull. 910: In preparation.

[3] VAN ORSTRAND, C E. *On the empirical representation of certain production curves* Journ Washington Acad Sci 15(2). 19–33 Jan 19, 1925

From this graph it appears probable that the placer gold alloys most commonly mined in Alaska have a fineness of about 870 parts gold in a thousand. As the dross seldom exceeds 1 percent, it follows that the corresponding content of silver is about 120 parts per thousand. One of the most significant features of these data, concerning which more will later be said, is the absence in Alaska or elsewhere in the world of placer gold alloys of a fineness much less than 600; and also the world-wide absence of any gold-silver alloys having a fineness of less than 400.

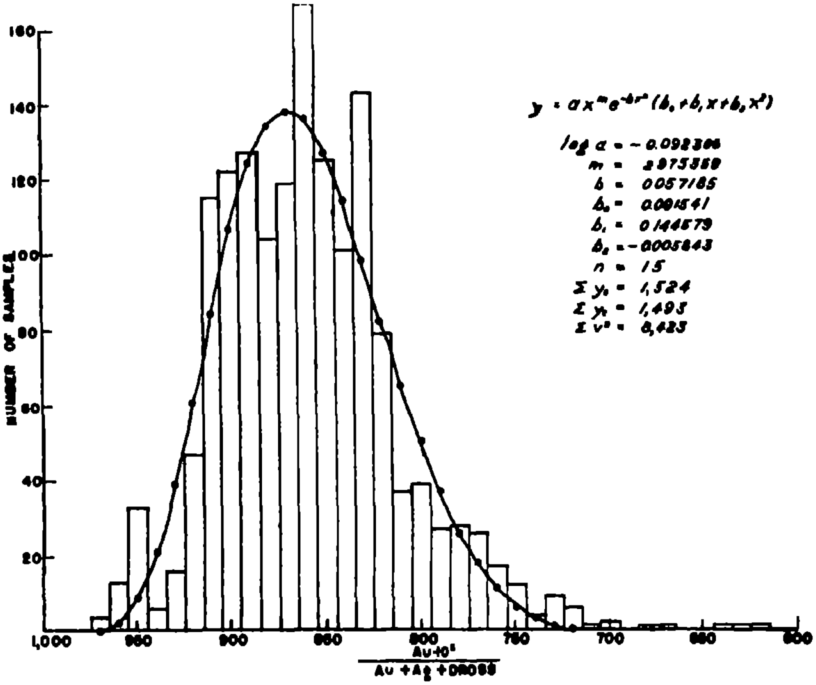

Fig. 1.—Frequency curve, showing fineness of placer gold in Alaska

One of the most ill-defined terms applied to natural gold alloys is the term electrum. According to Rose and Newman,[4] electrum means pale yellow natural alloys of gold and silver containing 15 to 35 percent of silver; but Dana[5] mentions two species of electrum containing over 38 percent of silver; whereas Lindgren[6] restricts electrum to an alloy containing 50 percent of silver. According to the first definition, if 1 percent of the alloy is allocated to dross, all natural gold alloys in the range of fineness between 840 and 640 parts gold in a thousand should be classified as electrum; and therefore about one-third of the natural gold alloys of Alaska are electrum. If the pale yellowish color is an indispensable part of the definition, many of the Alaskan alloys, in the range from 840 to 640 fineness, are not necessarily electrum. An increasing percentage of silver does modify the color of a gold-silver alloy, and the color of an artificial alloy containing 50 percent of silver is actually a faint yellowish white. But I suspect that the natural alloys that the ancients designated as electrum owed their pale color as much to elements of the dross as to their content of silver. Therefore, although the term electrum is of historical interest, it does not seem that it belongs in a handbook of mineralogy as a species or variety of the natural gold alloys, unless it is given a more exact chemical definition than it now has.

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[4] Rose, Sir Thomas K., and Newman, W. A. C. *The metallurgy of gold*, ed. 7, p. 46. 1937.

[5] Dana, James W. *The system of mineralogy*, ed. 6, p. 15. 1914.

[6] Lindgren, Waldemar. *Mineral deposits*, ed. 2, p. 229. 1919.

Many elements, usually in small quantities, have been found to form a part of the natural gold-silver alloys. Such accessory metals usually constitute from a half of 1 percent to 1 percent of the alloys. Copper and iron are the principal metals of the dross, but the ratio of these two elements to one another is extremely variable, such that either of them may preponderate greatly over the other. Yet a summation of the chemical analyses of gold, given by Hintze,[7] shows that the average quantities of copper and iron in the natural gold-silver alloys, is nearly equal. Small quantities of a number of other elements have also been detected in placer gold by chemical analysis, and doubtless traces of still others may be found by spectrographic analysis. The principal accessory metals that have been recognized by chemical analysis of the natural gold-silver alloys, are zinc, mercury, tin, lead, antimony, bismuth, nickel, cobalt, rhodium, palladium, iridium, and platinum; and of these all but antimony, bismuth, cobalt, and rhodium have been identified chemically in the placer golds of Alaska.

The physical properties of the natural alloys of gold and silver, ordinarily designated as free gold, are given scant consideration in books on mineralogy and economic geology; and some quite erroneous statements have been published. Thus in a recently published handbook it is stated that "gold is a yellow malleable metal with a specific gravity from 15.6 to 19.3, and a melting point at about 1,062° C." Pure gold does have the melting point stated, but its specific gravity is not to any considerable degree variable, being approximately 19.3 to the nearest digit in the first decimal place. And if the author's description referred to natural gold alloys of variable composition, then their melting points were not 1,062° C. Moreover, natural alloys of gold and silver are known that have specific gravities as low as 12.5 instead of 15.6. Hence the whole statement is erroneous.

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[7] HINTZE, CARL *Handbuch der Mineralogie* 1: 316–320 1904

The physical properties of gold and silver are well known and are carefully tabulated in reference books such as the International Critical Tables. But in this paper it is the natural alloys of gold and silver, rather than the pure metals, that are being discussed. Therefore, for present purposes, the following short tabulation of the physical properties of pure gold and pure silver will suffice:

TABLE 2.—PHYSICAL PROPERTIES OF GOLD AND SILVER

Property	Gold	Silver
Atomic weight	197.2	107.9
Specific gravity	19.3	10.5
Melting point (°C)	1063°	960°
Boiling point (°C)	2600°	1950°
Hardness (Moh's scale)	2.5	3.0
Electrical resistivity Ohms per cm^3 at 20° C	2.4×10^{-6}	1.6×10^{-6}
Magnetic susceptibility (mass unit) at 18° C	-0.15×10^{-6}	-0.20×10^{-6}
Thermal coefficient of linear expansion at 20° C	14.2×10^{-6}	18.9×10^{-6}
Crystallography	Face-centered cubic space lattice	Face-centered cubic space lattice
Length of side of cubic lattice (cm)	4.07×10^{-8}	4.08×10^{-8}
Atomic radius (cm)	1.44×10^{-8}	1.44×10^{-8}
Workability	Very malleable and ductile	Very malleable and ductile, but less so than gold.

Placer golds are well known to be natural alloys, principally of gold and silver, but judging from published descriptions little is known of their true nature. Much investigative work, to be sure, has been done on artificial alloys of different metals, including gold and silver, but even this information does not appear in our textbooks on mineralogy. In dry melts, gold and silver are continuously miscible in all proportions, like alcohol and water, and remain so after solidification, forming a solid solution analogous to albite and anorthite. Raydt[8] has studied the binary system of gold and silver, and has derived an equilibrium diagram, relating composition to temperature, which is shown in Fig. 2.

This diagram shows continuous solidus and liquidus curves, without maximum or minimum points. It should also be emphasized that gold and silver, as well as all other metals that have solidified from dry melts, exist as crystallites, usually in allotriomorphic aggregates. These crystallites, in any one alloy, do not necessarily have the same chemical composition, nor, in fact, is any one crystallite necessarily chemically homogeneous.

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[8] RAYDT, U. *Über Gold-Silberlegierungen.* Zeitschr. anorg. Chemie 75: 58–62. 1912.

Copper and iron, however, the principal metals of the dross, behave differently, when melted with gold and silver. Copper, for example, is miscible in all proportions in the liquid state, either with gold or with silver, and forms a solid solution with gold in the solid state; but copper and silver have limited ranges of miscibility in the solid state, from 0 to 5 percent and from 95½ to 100 percent copper. Iron, on the other hand, shows unlimited miscibility with gold in the liquid state, but complete immiscibility with silver; and in the solid state, alpha iron at 20° C shows solid solution with gold in the ranges from 0 to 20 percent, and 82 to 100 percent iron, whereas with silver iron is completely immiscible in the solid state.

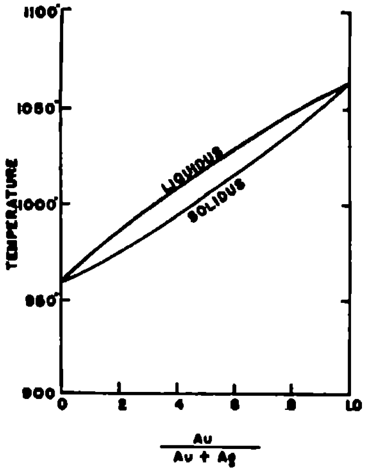

Fig 2.—Equilibrium diagram for artificial gold-silver alloys

The phase relations shown by Raydt's equilibrium diagram, and additional phase relations known to exist between binary and ternary systems of gold, silver, copper, iron, and other elements studied in artificial melts, do not necessarily hold for natural alloys, because the effects of still other components, such as quartz, water, base metals, and the so-called mineralizers have not been evaluated. It seems likely, however, that the relationship observed in dry melts will in some measure, perhaps in large measure, apply to the natural alloys of gold and silver; and for this reason placer gold should be considered to be altogether or in large part a solid solution of crystalline gold and silver, with small quantities of other metals, in unknown phase relationships. Yet certain significant differences between natural and artificial alloys have been observed, which seem worthy of emphasis.

If any two metals were completely immiscible in the solid state, so that they solidified as individual grains in a eutectic or mechanical mixture, it should be possible from a chemical analysis to compute those physical properties such as specific gravity, which are functions of additive quantities like mass and volume. But gold and silver crystallize from dry melts as solid solutions, or, if you will, as atomic mixtures; and if the natural alloys of gold and silver are likewise solid solutions, it should not be possible from chemical data alone to compute their specific gravities. This is found to be true. But it is a matter of considerable interest to assume that the eutectic relationship holds, and to compute, either from artificial mixtures of known weights of gold and silver or from chemical analyses of the natural alloys of these two metals, the specific gravities that should result. These theoretical values can then be used as standards, with which to compare the respective alloys, in order to determine whether the latter show contraction or expansion in volume, and the order of such changes, as compared with mechanical mixtures of the two components. For artificial alloys of gold and silver, this has been done by Matthiessen[9] and by Hoitsema.[10] The specific gravities have also been computed theoretically by McKeehan[11] from X-ray analysis

The molecular composition indicated by Matthiessen and McKeehan were converted to percentages of gold and silver by weight, to correspond with the form of the ratios given by Hoitsema. From these ratios, and from the specific gravities of the pure gold and pure silver used by these three men, the specific gravities and specific volumes were then computed, which should exist if the two components were mechanically mixed. The differences between these specific volumes, and those found by actual measurement or by X-ray analysis, were then compared, giving a column of differences which show whether volumetric contraction or expansion took place. All these data are shown in Tables 3–5.

An adjusted graph of the specific gravities, utilizing the data of Matthiessen, Hoitsema, and McKeehan has been published in the

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[9] MATTHIESSEN, A *On the specific gravity of alloys.* Philos. Trans Roy. Soc London 150: 183. 1859.

[10] HOITSEMA, C *Die Dichte von Goldkupfer und Goldsilberlegierungen.* Zeitschr. anorg Chemie 41: 66–67. 1904.

[11] McKEEHAN, L W. *The crystal structure of silver-palladium and silver-gold alloys.* Phys Rev. (ser 2) 20: 429 1922

TABLE 3 —SPECIFIC GRAVITIES AND SPECIFIC VOLUMES OF ARTIFICIAL ALLOYS

Composition[1]	Spec. Grav[2] (true)	Spec. Grav (computed)	Spec Vol (true)	Spec. Vol (computed)	Spec Vol (differences)
Au	19.265				
Au_6Ag	18.041	17 999	0 05543	0 05556	+0 00013
Au_4Ag	17 540	17 493	.05701	05717	+ .00016
Au_2Ag	16 354	16 315	06115	06129	+ 00014
AuAg	14 870	14 847	06725	06735	+ .00010
$AuAg_2$	13.432	13 383	.07445	07472	+ 00027
$AuAg_4$	12 257	12 215	08159	08187	+ 00028
[3]$AuAg_6$	11 760	11 715	08503	08536	+ 00033
Ag	10 468				

[1] Atomic weights of 197 and 108 were used by Matthiessen in determining the percentages of gold and silver in the specified alloys

[2] Specific gravity determinations by A Matthiessen

[3] Owing to a typographic error, this reads $AuAg_5$ in the original paper

TABLE 4 —SPECIFIC GRAVITIES AND SPECIFIC VOLUMES OF ARTIFICIAL ALLOYS

Parts per thousand		Spec. Grav[1] (true)	Spec Grav[2] (computed)	Spec Vol (true)	Spec Vol (computed)	Spec Vol (differences)
Au	Ag					
1000	0	19 26	— —	—	—	—
917	83	18 08	18 000	05531	05556	+0 00025
843	157	16 96	17 009	05896	.05879	− 00017
750	250	16 03	15 907	06238	06287	+ 00049
667	333	15 07	15 038	06636	06650	+ 00014
583	417	14 24	14 250	07023	07018	− 00005
500	500	13 60	13 540	07353	07381	+ 00028
417	583	13 00	12.913	07692	07744	+ 00042
333	667	12 38	12 328	08070	08112	+ 00042
250	750	11 78	11 799	08480	08475	− 00014
167	833	11 28	11 314	08861	08839	− 00022
0	1000	10 45	—	—	— —	—

[1] Specific gravity determinations by C Hoitsema

[2] *A number of corrections were made in the specific gravities and specific volumes computed by* Hoitsema.

TABLE 5 —SPECIFIC GRAVITIES AND SPECIFIC VOLUMES OF ARTIFICIAL ALLOYS

Composition[1]	Spec Grav[2] (X-ray)	Spec Grav (computed)	Spec Vol (X-ray)	Spec Vol (computed)	Spec. Vol (differences)
Au	19 24	—	—	—	—
Au_9Ag	18 24	18 365	05482	05445	−0 00037
Au_4Ag	17.44	17.490	05734	05718	− 00016
Au_5Ag_2	16.06	16 615	06227	06019	− 00208
Au_3Ag_2	15 31	15 740	06523	06353	− 00179
AuAg	14 74	14 865	06784	.06727	− 00057
Au_2Ag_3	13.50	13 990	07407	07148	− 00259
$AuAg_4$	11 93	12.240	08382	08170	− 00212
Ag	10.40	—	—	—	—

[1] Atomic weights of 197 2 and 107 88 were used by McKeehan in determining the percentages of gold and silver in the specified alloys

[2] X-ray observations and derived specific gravities by L W McKeehan

International Critical Tables.[12] This, with some corrections, is shown in Fig. 3.

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[12] *International critical tables of numerical data. Physics, chemistry and technology* **2**: 590 1927.

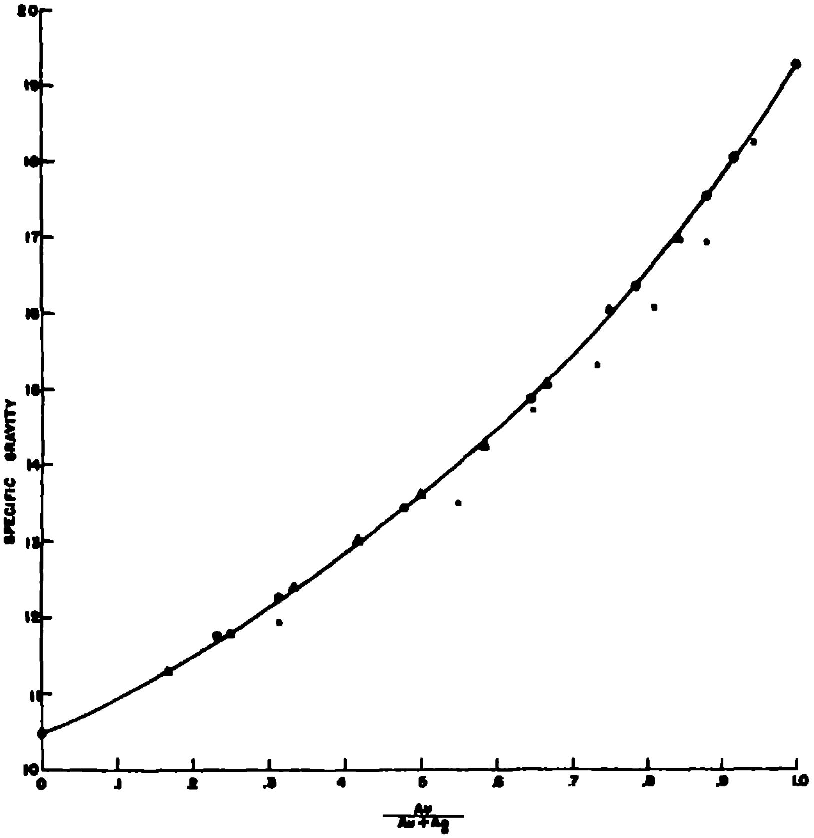

Fig 3.—Adjusted curve, showing specific gravities of artificial gold-silver alloys as obtained by Matthiessen○, Hoitsema△, and McKeehan●

The computation of the specific gravity of a binary alloy from its chemical composition, if the two components are considered to be mechanically mixed, is simply done by means of the following formula:

$$S = \frac{M_1 + M_2}{V_1 + V_2} = \frac{M_1 + M_2}{\frac{M_1}{S_1} + \frac{M_2}{S_2}} = \frac{(M_1 + M_2)\, S_1S_2}{M_1S_2 + M_2S_1}$$

where M_1 and M_2 are the weights, and S_1 and S_2 are the corresponding specific gravities of the two components. To compute the specific gravity of a n-ary alloy from its chemical composition, upon the assumption that all the components are mechanically mixed, the above formula has been expanded to read as follows:

$$S = \frac{(M_1 + M_2 + M_3 + \cdots + M_n)\,(S_1S_2S_3 \cdots S_n)}{(M_1S_2S_3S_4 \cdots S_n) + (M_2S_1S_3S_4 \cdots S_n) + (M_3S_1S_2S_4 \cdots S_n) + \cdots}$$

$$\frac{1}{\cdots + (M_{n-2}S_1S_2 \cdots S_{n-3}S_{n-1}S_n) + (M_{r-1}S_1S_2 \cdots S_{n-3}S_{n-2}S_n) +}$$

$$\frac{1}{+ (M_nS_1S_2 \cdots S_{n-3}S_{n-2}S_{n-1})}$$

Now let us apply this formula to four complete chemical analyses of placer gold alloys from Alaska, which have recently been made in the laboratory of the U. S. Geological Survey. These are presented in Table 6.

TABLE 6.—ANALYSES OF PLACER GOLD FROM ALASKA

Constituent	1	2	3	4
Gold	83.90	80.50	87.53	92.69
Silver	10.42	18.21	11.12	6.16
Platinum	.01	.20	.28	.42
Iridium		.02	.05	trace
Palladium			trace	
Lead		.06	.07	.08
Mercury		.10	.05	.02
Iron	1.02	.08	.07	.07
Nickel	.007			
Copper	.002	.03	.01	.04
Zinc		.04	.03	.01
Tin		trace	trace	trace
SiO_2		.43	.40	.77
SiO_2, Al_2O_3, and Cr_2O_3	.432			
Insoluble in aqua regia	1.67			
Totals	97.461	99.76	99.61	100.26

1. Squirrel Creek, Goodnews Bay district, southwestern Alaska. E. T. Erickson, analyst.
2. Seventymile River, Eagle district, east-central Alaska. R. E. Stevens, analyst.
3. Fourth of July Creek, Eagle district, east-central Alaska. R. E. Stevens, analyst.
4. Woodchopper Creek, Circle district, east-central Alaska. R. E. Stevens, analyst.

When the specific gravities of these four samples are computed, upon the assumption and with the formula above given, some anomalous results appear. These are given in Table 7.

TABLE 7.—SPECIFIC GRAVITIES AND SPECIFIC VOLUMES OF PLACER GOLD FROM ALASKA

Sample No.	Spec. Grav. (true)	Spec. Grav. (computed)	Spec. Vol. (true)	Spec. Vol. (computed)	Spec. Vol. (differences)
1	13.32	17.43	0.07508	0.05737	−0.01771
2	15.18	16.69	.06588	.05992	− .00596
3	16.00	17.61	.06250	.05679	− .00571
4	15.87	18.31	.06301	.05461	− .00840

The experimental work by Matthiessen shows that when pure gold and pure silver are melted together in definite proportions, there results a contraction in volume of small magnitude, regardless of the proportions of the two metals. Hoitsema's results show both a contraction and an expansion of volume, for different compositions, but the differences between the true and computed specific gravities are at least of the same order of magnitude as those found by Matthiessen. The results obtained from McKeehan's data are not strictly comparable with those obtained by Matthiessen and Hoitsema but are given for the sake of comparison. When the same computations are made from chemical analyses of placer golds, as shown above, there results an expansion in volume, of large and variable magnitude. Parenthetically it may be added that sample no. 1 is held by a strong electromagnet, although both gold and silver are diamagnetic. The reason for these differences between the artificial and natural alloys of gold and silver is not known, but there seem to be ample grounds for suspecting that complex phase relationships may exist. If this is true, a careful study of placer gold by physical and chemical methods is needed, in order to discover the present compositions of such alloys, both in bulk and in crystallites or grains of microscopic dimensions. A knowledge of the present physical and chemical conditions of these alloys should also lead to a better understanding of the temperatures, pressures and other conditions that existed in gold-quartz veins at the time of their formation.

The solubilities of the natural alloys of gold and silver in inorganic acids also have a bearing upon their occurrence in nature, both in their bedrock habitats and in their subsequent occurrence in placers. Gold is not appreciably attacked by any single acid except selenic acid (H_2SeO_4), but it dissolves readily in solutions generating the nascent halides, and therefore in aqua regia. Silver, on the other hand, is dissolved by boiling concentrated sulphuric acid, by dilute nitric acid and by hydriodic acid, and is attacked by all the halides, by warm selenic acid, and to a very slight extent by hydrochloric acid in the presence of oxidizing agents. Silver has also been shown to be slightly soluble in distilled water, to the extent of 3.7×10^{-6} grams per liter. But just as the physical properties of the alloys of gold and silver can not be directly inferred from the physical properties of the two pure components, so the solubilities of these alloys are not linear functions of the solubilities of pure gold and silver.

One profitable line of investigation in connection with the study of gold placers would be a study of the solubilities of artificial and natural gold-silver alloys in the inorganic acids and other solvents that might be expected to occur in surface and ground waters. At present the most suggestive fact of this sort results from the well-known process of quartation, or inquartation (as it is sometimes called), which has been used for over 600 years for parting silver from gold-silver alloys. Natural gold alloys are not attacked either by nitric or sulphuric acids, but if a sufficient amount of silver is added to the alloy, practically all the silver can then be dissolved by nitric acid at a temperature of 115° F. Essentially the same result is obtained by the use of sulphuric acid. The really interesting feature, however, is the fact of the limits of partial and complete solubility; and these are shown in the accompanying diagram, taken from Tammann's[13] work. (See Fig. 4.)

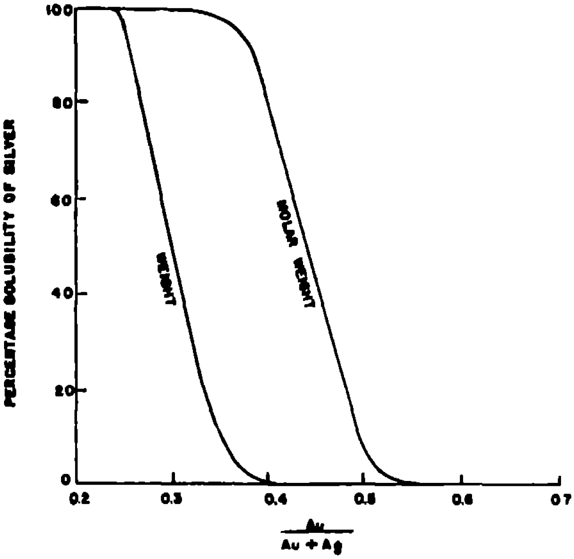

FIG. 4.—Sketch showing amounts of silver dissolved by nitric acid from artificial gold-silver alloys.

The fact particularly to be noted in this diagram is that no silver can be dissolved by inorganic acids from an artificial gold-silver alloy having the general composition of placer gold, because the high content of gold renders them practically insoluble. What would be the probability, then, that any appreciable amount of silver could be dissolved from placer gold by cold surface waters? Further reference will later be made to this topic.

GEOGRAPHIC DISTRIBUTION OF GOLD PLACERS IN ALASKA

It is not the purpose of this paper to tabulate and describe the gold placers of Alaska, though such a compilation might indeed be a useful piece of work. Instead, the writer aims principally to point out the known facts that have a bearing upon the origin and accumulation of such placers; and in order to accomplish this objective, geographic references will be made only secondarily.

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[13] TAMMANN, GUSTAV. *A textbook of metallography*, ed. 3, p. 314. 1925. (Translated from the German by R. S. Dean and L. G. Swenson.)

The principal fact to be noted regarding the geographic distribution of gold placers in Alaska is that all the really important deposits occur in the unglaciated part of the Territory. (See Fig. 5.) This unglaciated placer-bearing region lies north of the Alaska Range, south of the Brooks Range, and extends westward and southwestward to the Arctic Ocean and Bering Sea.[14] To be sure, several small placer camps are located south of the Alaska Range, but these in toto produce no considerable part of the placer gold mined in Alaska. Granitic rocks, which are considered to be the ultimate source of most of the placer gold, are widely distributed in Alaska south of the crest of the Brooks Range, and therefore no a priori reason exists why lode and placer deposits should not have coexisted north and south of the Alaska Range before the beginning of the Ice Age, and doubtless this was true. But glacial action in the Alaska Range and coastal ranges, and seaward therefrom, was so severe that the country rock was largely denuded, thus eroding and dissipating most of the pre-Quaternary alluvial deposits. In general, there has been insufficient time and erosive action since the retreat of the ice to produce new gold placers from bedrock sources. But at some localities in the glaciated regions, auriferous glacial deposits have been reconcentrated by Recent streams, thus producing workable placers; and, in fact, at one locality in the Cache Creek district, a glacial deposit has constituted a low grade placer. At other localities in southern Alaska there remain remnants of preglacial placers, which were located in valleys that were transverse to the principal flow lines of the ice, or were otherwise protected from glacial scour. These explainable exceptions in no way vitiate the general rule that the important placers are restricted to the unglaciated part of Alaska.

Most of the workable gold lodes, however, lie south of the Alaska Range, or in southeastern Alaska southwest of the Coast Range, though a number of small gold lodes have been discovered and are being mined in the unglaciated region of interior Alaska. The meaning of this distribution of the gold lodes is less apparent, but it is possible that the denudation of bedrock by glaciation has been an important factor favoring the discovery of lodes in southern and south-

[14] CAPPS, STEPHEN R. *Glaciation in Alaska.* U. S. Geol Surv. Prof. Paper 170-A, pl

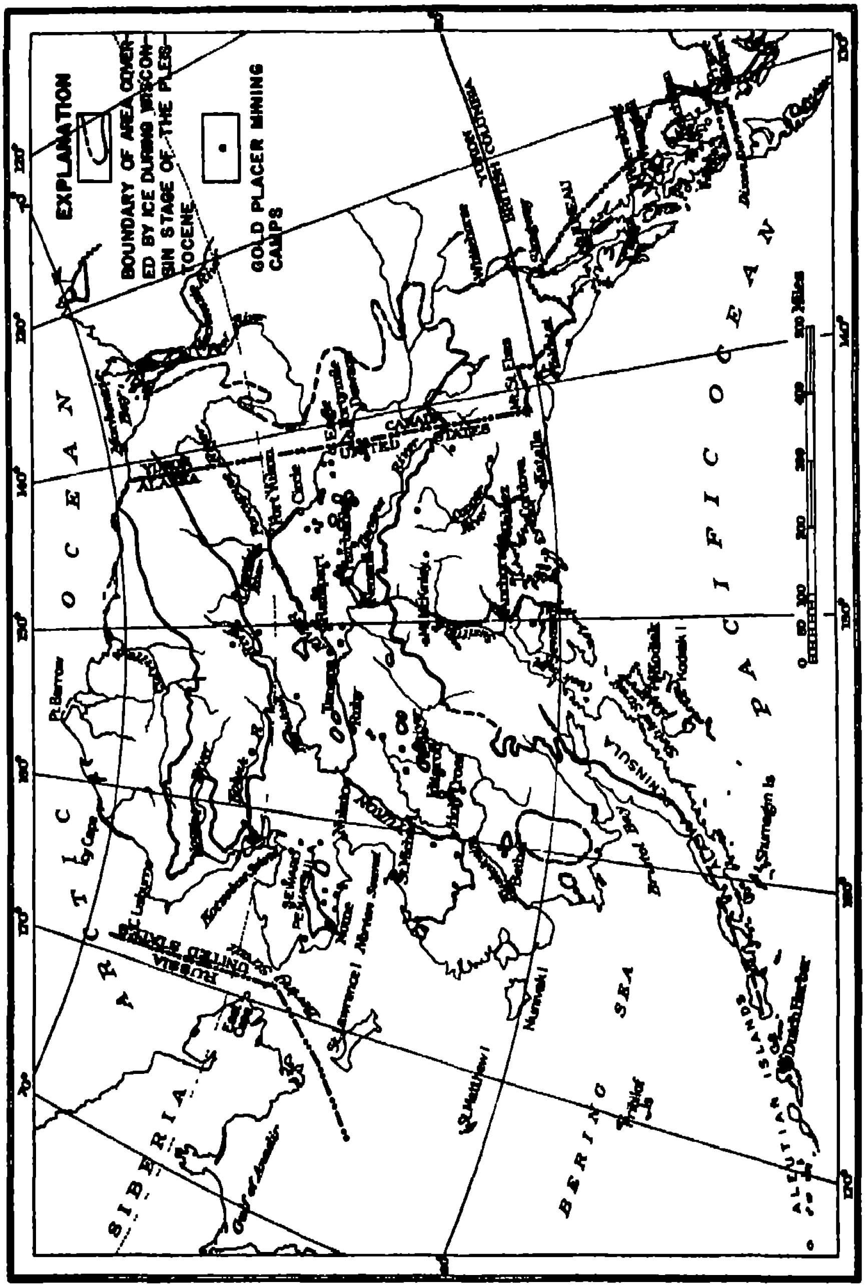

Fig 5 —Localization of gold placers in unglaciated areas of Alaska

eastern Alaska. On the other hand, the heavy cover of residual and eluvial deposits in interior Alaska has certainly been a handicap to lode prospecting, and this may be an important factor in their apparent scarcity in that region.

CLASSIFICATION OF GOLD PLACERS

A complete classification of gold placers is beyond the scope of this paper. There are probably types of placers with which the writer is not familiar, and there are certainly some, such as aeolian placers, that have not been recognized in Alaska. The following simple classification, therefore, aims mainly to tabulate the kinds of placers that are known in Alaska:

I Residual and eluvial placers.
II. Fluviatile placers.
  A. Recent stream placers
  B Ancient stream placers.
    1 Bench stream placers
    2. Buried stream placers.
    3. Compound stream placers
  C. Hard rock sedimentary reefs.
III Glaciofluviatile placers
IV Beach placers
  A. Recent beach placers
  B Ancient beach placers
    1. Elevated beach placers.
    2. Buried beach placers

Residual and eluvial placers are those that have been formed in or almost in situ, as a result of deep residual alteration and disintegration of a gold-bearing bedrock. Placers of this type are geographically uncommon and are of small economic significance in Alaska. No sharp distinction can be made between residual and eluvial placers, and in fact it is doubtful whether a truly residual deposit can be said to exist, because this would imply an almost total absence of lateral movement of the gold-bearing detritus, and a concentration largely by chemical removal of rock constituents, and a downward segregation of gold toward bedrock. For this reason these two types are grouped into a single class. Perhaps the best example of combined residual and eluvial placers in Alaska is in the Iditarod district, where a mass of monzonite forms the country rock along a divide at the head of several streams, notably Flat Creek. This monzonite is cut by many small seams and stringers of gold-bearing quartz, some of which have been exposed by mining operations. At this locality deep residual alteration of the monzonite has taken place, and by the combined action of gravity, frost-thrusting, and ground water a great volume of loosened and disintegrated bedrock is slowly moving downhill into the adjoining valleys. Some of this material might possibly be classed as a residual placer, but another part, which has clearly migrated down the slopes of the ridge but has not yet been handled by running surface water, is a good example of an eluvial placer.

Most of the commercial placers of Alaska are of the fluviatile type. These have been divided upon the basis of their relative ages into present and ancient stream placers, but in this connection a sharp distinction must be made between the age of the present stream gravels, and the age of the alluvial gold contained in them. In speaking of southern Alaska, it was stated that sufficient time had not elapsed since the retreat of the ice for the present streams to erode from bedrock sources, and to concentrate workable gold placers. This is believed also to be true in interior Alaska, but postglacial and Recent time in Alaska are not necessarily synonymous terms, and the term Recent may connote a longer interval of time, at least at some localities, than the term postglacial But a more important consideration is that a large volume of already disintegrated debris, and also older placers, have been continuously available to the Recent streams of interior Alaska, throughout their life history. Hence Recent placers do really exist in interior Alaska, though it is doubtful whether any considerable part of the gold contained in them was eroded from bedrock in Recent time. Recent placers must therefore be defined as placers in which the component gravels have been moved to their present sites during a single erosional cycle, controlled by a nearly static base level of erosion, and within the Recent epoch. Many examples of Recent stream placers could be cited, but their common occurrence renders this unnecessary. Generally speaking, the Recent stream placers are of less economic value than the older fluviatile placers.

The ancient stream placers consist of gold-bearing fluviatile gravels that were deposited during one or more cycles of erosion preceding the last one. Such placers are arbitrarily divided into bench and buried placers, upon the basis of the altitude of their underlying bedrock, as compared with the altitude of the bedrock lying below a body of adjoining stream gravels. Bench placers are commonly developed as the result of a renewed cycle of erosion, in which the local base level of erosion is lowered at a rate greater than the rate at which a stream can lower by erosion its preexisting valley floor. If this occurs, there will remain uneroded remnants of the old bedrock floor, covered by more or less alluvial material at altitudes appreciably higher than the bedrock and alluvium of the new valley floor. Such uneroded remnants of auriferous alluvium constitute true bench placers. If, however, the rate of lowering of the local base level of erosion is equal to or less than the erosional rate of the stream, the older bedrock surface will be concurrently lowered and its overlying cover of alluvial material will be continuously reworked, in such a manner that neither bedrock nor alluvial terraces will be evolved. The same result more frequently materializes as a result of variable rates of the two functions, so that terraces have been formed and subsequently destroyed, leaving little or no trace of their former existence. In such cases the gold is really ancient bench gold, but the gravels now containing it are Recent placers. Similarly, however, the gold of the present bench placers may have rested temporarily for considerable periods in still older placers. Many splendid examples of true bench placers occur in the Fortymile district. On the other hand, Mastodon Creek, in the Circle district, is a good example of a valley in which the terraces were destroyed almost as fast as they were created.

Buried placers are those that resulted from an elevation of the local base level of erosion, or from other causes such as aeolian action, so that ancient auriferous gravels that formerly constituted a valley floor were progressively buried by a general alluviation. In a certain sense, all placers are buried placers because erosion in the headwater part of a valley can take place contemporaneously with alluviation in its lower stretches, even during an erosional cycle initiated by a lowering of the local base level of erosion. But the term buried placers is here used to designate gold-bearing alluvial deposits which were formed in an erosional cycle that antedated the cycle during which they were buried. Unlike bench placers, buried placers can not be simultaneously created and destroyed, for theoretically in the sites of buried placers, erosion of bedrock is nil, though it will continue to exist in the headwater parts of a valley unless or until aggradation reaches that far upstream. Some of the placers of the Fairbanks district are examples of buried placers, but for the most part they are more completely described as compound placers, because they have been materially affected by one or more erosional cycles that postdated their burial.

Compound stream placers comprise many gold-bearing alluvial deposits, which on geomorphic grounds could be divided into an almost endless number of species. The development of these subordinate types is a function of the number and character of the variations in the local base level of erosion, and also of the rate of change of such variations; and these factors, in turn, are functions of simpler ones, which often are still too complex for simple exposition or analysis. The placers of the Livengood district, to take a relatively simple example, were at one stage in their development buried placers. As a result of an elevation of the base level of erosion, accompanied by extensive aggradation, Livengood Creek was superposed onto one side of its old valley wall. By a subsequent lowering of the base level of erosion, a new valley floor was carved contiguous to the old valley floor, but separated therefrom by a bedrock reef. Finally the new valley floor was so greatly eroded that the altitude of its bedrock floor became less than that of the old bedrock floor, whereupon the old buried placer came to have the general appearance of a bench placer. Similarly bench placers can be rebuilt to simulate simple buried placers; bedrock terraces may be evolved which are younger than their contiguous valley floors; and in the geologic interval ordinarily considered to comprise the geomorphic record, these and other anomalous processes may be several times repeated. Consequently compound stream placers are as difficult to classify as sedimentary rocks, and at present their characteristics are much less well known. Many of the ancient placers of interior Alaska are compound placers, but at few places have their complete histories been deciphered.

Alaska contains no auriferous hard-rock reefs of economic value, similar to the Witwatersrand deposits of South Africa. But Tertiary sedimentary rocks carrying sparsely disseminated gold, occur south of the Yukon River in a narrow belt extending from the international boundary west-northwest for more than 100 miles. The conglomerates that constitute a part of this sequence of rocks have clearly acted as a proximate source of the gold now contained in the bench and stream placers of this general district. This belt of Tertiary rocks is the best, though not the only, example of auriferous hard-rock reefs known in Alaska.

Glacial action tends to dissipate, rather than to concentrate, the heavy metals and minerals, but few glacial deposits are altogether free of the effects of running water. Some glaciofluviatile deposits, however, are fairly well sorted, and except for their original heterogeneity are not especially different from normal stream deposits. Hence if glacial and more particularly glaciofluviatile deposits were derived from a gold-bearing bedrock, and were not too far removed by glacial action from their original sources, the glacial dissipation of the gold might be small enough to render such deposits workable as placers. One of the best examples of a glaciofluviatile placer conforming to these conditions may be seen on Bird Creek, in the Cache Creek district.

If gold-bearing rocks occur close to a body of standing water large enough to produce marked wave action along its bounding beaches, gold placers may be formed by the sorting action of the waves. The formation of such beach placers, however, is often aided by the prior concentration of gold as fluviatile placers in valleys which discharged to the sea. Beach placers are known in Alaska at a number of localities, but the richest and best known of these are at Nome, bordering upon Norton Sound. Here are found Recent beach placers and ancient ones, the latter including both the elevated and the buried types.

The conditions at Nome can best be understood by visualizing a sloping foreland, with a width of more than 3 miles, which lies between low hills to the north and Norton Sound on the south. Within this foreland, the bedrock is covered by alluvial deposits ranging in thickness from 30 to 120 feet, and of these the lower few feet superjacent to bedrock are beach gravels, mainly of Pliocene age. The overlying deposits are both marine and terrigenous in origin, the terrigenous deposits lying for the most part closer to the hills. Starting 3 miles from the sea, a bedrock profile drawn southward toward the sea shows an initial altitude of about 70 feet above sea level, but passes below sea level about three-fourths of a mile north of the present beach. At the north end of this bedrock profile is a nearly vertical cliff, 12 to 14 feet high; and here there exists an alluvial cover about 85 feet thick, of which the lower 3 to 5 feet are Pliocene beach gravels, whereas the overlying material consists mainly of terrigenous deposits of Quaternary age. From the base of this cliff, bedrock slopes gently and gradually southward to and beyond the present strand line, and upon this sloping surface are a number of sites at which pronounced concentrations of gold were effected by an advancing Pliocene sea. Without citing the local names of these successive sites, it suffices to state that there are five such beaches on bedrock, of which the two most southerly, which lie below the present level of the sea, are the oldest; whereas the other three, which are above the present sea level, are progressively younger to the north, the youngest being at the base of the above-mentioned bedrock cliff. As the sea subsequently retreated, another auriferous beach was formed about half a mile from the sea, but not on bedrock; and finally, the present auriferous beach was built. From the fossil record, the sixth (non-bedrock) beach is also of Pliocene age, so that a long record of Pleistocene marine sedimentation appears not to be present in this area. This conforms with conditions found elsewhere along Bering Sea, which point to the presence of a strand line far seaward of the present strand line, during a large part of Pleistocene time. From these general conditions, it is easily understood how and why there occur at Nome present, ancient elevated, and ancient buried beach placers.

BEDROCK SOURCES

The natural gold-silver alloys of Alaska are associated, either directly or indirectly, with granitic rocks, or with their surficial equivalents; and the general term granitic rocks is here used to include granite, monzogranite, quartz monzonite, granodiorite, and quartz diorite, together with their quartz-poor equivalents. Few if any quartz-free granitic rocks appear to be genetically associated with gold, but there are some, such as the monzonite at the head of Flat Creek, in the Iditarod district, that are distinctly low in silica.

Granitic rocks of several ages have been identified in Alaska. The oldest of these is a pre-Cambrian formation called the Pelly gneiss, which occurs in east-central Alaska and consists dominantly of massive augen gneiss grading into feldspathic quartz-mica schist. Cockfield,[15] of the Canadian Geological Survey, implies though he does not definitely state, that some part of the placer gold of the Sixtymile district, of Yukon Territory, is genetically related to the Pelly gneiss, but no evidence of such a relationship has so far been discovered in Alaska.

The granitic rocks of the Coast Range and the Alexander Archipelago of southeastern Alaska, of the coastal ranges of southern Alaska, of parts of interior Alaska, and of the Brooks Range of northern Alaska are considered to be mainly of Mesozoic age. It is believed, however, that these granitic rocks range in age from Middle Jurassic to Lower Cretaceous, being emplaced in more than one geologic epoch and probably in several stages. The granitic rocks of the Coast Range, according to Buddington,[16] consist principally of granodiorite, quartz monzonite, and quartz diorite, in the order named; but to the southwestward, in the Alexander Archipelago, the granitic rocks appear to be less silicic and may be somewhat older than those of the Coast Range proper. The granitic rocks of the coastal ranges of southern Alaska are also believed to antedate the granitic rocks of the main Coast Range, being probably of Middle Jurassic age. In interior Alaska, the Mesozoic granitic rocks include mainly quartz diorite and granite, with few intrusives of monzonitic character. They may be either of Jurassic or Cretaceous age, as the stratigraphic evidence of their geologic age is lacking. On rather insufficient data the granodioritic rocks of the Brooks Range are likewise considered to be either of Jurassic or Cretaceous age. Workable gold-bearing quartz veins and lodes of other types have been found in the vicinity of some of the Mesozoic granitic rocks, and to a greater extent where placers are not now present, than where they are. Such lodes appear to represent mainly the mesothermal type of mineralization.

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[15] COCKFIELD, W. E *Sixtymile and Ladue Rivers Area, Yukon* Can Geol Surv Mem 123: 49 1921.

[16] BUDDINGTON, A F, and CHAPIN, THEODORE *Geology and mineral deposits of southeastern Alaska* U. S. Geol. Surv. Bull. 800: 177. 1929.

The Tertiary period also was characterized by the intrusion of granitic rocks, in one or more stages of emplacement. Certain early Tertiary granitic rocks appear to be normal granite, quartz monzonite and quartz diorite, but another type believed to be of later Tertiary age are nearly everywhere quartz monzonite or monzonite, relatively low in free silica, and carrying pyroxene as the principal dark mineral. Such rocks are widely distributed in southwestern Alaska, and are rated as second in importance as producers of placer gold. Much mineralization has been found in and near the mid-Tertiary granitic rocks, in the vicinity of some of the derived placers, but few important lodes of this age have been discovered. In general, the gold occurs in small discontinuous quartz veins and stringers, which appear to represent fillings in shattered epithermal zones. Cinnabar is almost everywhere associated with the placer gold that has been derived from the mid-Tertiary granitic rocks, and some mercury lodes of this age have been successfully mined.

FORMATION OF PLACERS

Since most of the placers of Alaska are of fluviatile origin, and even the beach placers were in some measure concentrated as preexisting fluviatile deposits, the formation of placers deals mainly with the erosion of gold from bedrock sources, and its transportation and concentration by the action of streams.

Many data indicate that most of the placer gold of Alaska was liberated from its bedrock sources long before it was finally deposited in the placers that are now being mined. In other words, it is believed that much of this gold has been handled and rehandled by streams in many successive geomorphic cycles. In east-central Alaska, for example, the gold that originated in the Mesozoic granitic rocks south of the Yukon River, began to be freed from its bedrock sources when those rocks were first bared to erosion; and since a considerable part of the gold was deposited, and some of it still remains, in the early Tertiary conglomerates of this area, the long alluvial history of the gold in this area is not open to question. At most localities, however, this generalization is not directly provable, though it is strongly suggested by the presence of large quantities of placer gold in certain localities where few or no evidences of mineralized bedrock can be found; by great differences in fineness between placer gold and the gold of geographically contiguous lodes; and in fact by the mere presence of deeply truncated laccoliths and stocks of granitic rocks in the drainage basins where workable placers occur. Naturally, since the parent rocks range in age from Middle Jurassic to mid-Tertiary, no generalized statement is possible regarding the ancient climatological conditions under which the country rock was first disintegrated and made available to stream action. But during some epochs, notably just before the general epeirogenic uplift at the end of the Pliocene epoch, a large volume of residual and eluvial material is believed to have mantled much of Alaska. In interior Alaska, for example, there are placer camps, as at Poorman, where practically all the gravels of the placers are vein quartz and chert. In such localities, it seems certain that the concentration of siliceous rocks is due to the disintegration and destruction of the other rocks with which they were originally associated. Probably, therefore, a large part of these siliceous gravels were derived from bedrock sources long before the Quaternary period.

In streams having gradients of the same order as those obtaining in the medial courses of the usual placer streams of interior Alaska, the downstream vector of movement for gold appears to be small. Splendid examples of this feature are apparent in Fourth of July, Coal, and Woodchopper Creeks, in east-central Alaska, where important placers have been concentrated from the above-mentioned Tertiary bedrock in the present valleys during several erosional cycles. The Tertiary rocks cross these three valleys as a belt several miles in width. Upstream from these gold-bearing rocks no placers exist, and downstream from them the workable placers terminate in a very short distance The same feature may also be noted in Hunter and Little Minook Creeks, in the Rampart district, where the present placers have been reconcentrated from a belt of unconsolidated auriferous Pliocene gravels, that crosses the valleys of these two streams. Some of the very fine gold, of course, travels many miles downstream, and lodges in the large trunk valleys; but the amount appears to be very small in comparison with that which is repeatedly handed by streams in successive erosional cycles, and still remains in the original valleys where it was first concentrated.

Since most of the placers of interior Alaska are classified as compound types, no simple exposition of their general geomorphic history can be attempted; but it is relevant to review the classical hypothesis of their formation during a single cycle of erosion. (See Fig. 6.) In most small streams much of the alluvial material is in course of progressive movement from the headwaters downstream. In the uppermost stretches all this alluvium, from the surface to bedrock, at times of flood is moved downstream, and redeposited. But in most small streams there is a zone in the valley downstream from which the alluvial material on or near bedrock will not be further disturbed, even at the highest flood stages, unless the stream is rejuvenated by a lowering of its base level of erosion. The position and length of this critical zone varies with the strength of the current, the size and specific gravity of the alluvial materials, and with several other factors; yet its existence is fairly well substantiated. If a gold lode occurs at or near the head of a valley, the gold on being liberated by the process of weathering migrates downstream with the other stream detritus, gradually working its way toward bedrock. Somewhere in the critical zone, however, most of this gold, and all the coarse gold, finally comes to rest; and from this zone downstream the current of the stream is slower, and the detritus becomes thicker, so that the stream can no longer erode to bedrock. This critical zone, which lies between the headwater stretch of intermittent movement of all debris and the downstream stretch of no movement of the debris near bedrock, marks the downstream terminus of the paystreak; but the gold in process of downstream migration is also present upstream from the critical zone, and such gold may or may not constitute a paystreak, depending upon various factors. But stream erosion is a continuous process, in the course of which the valley is either extended backward into its divide; or, if another headwater stream is flowing in the opposite direction, the divide between the two streams will be lowered.

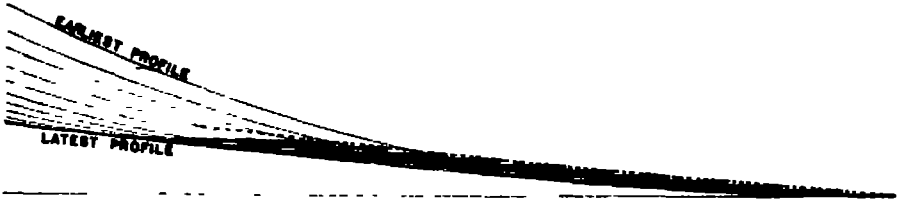

Fig 6.—Successive longitudinal profiles of a valley, showing formation of a paystreak progressively upstream, with overlying alluvium omitted (Vertical scale greatly exaggerated)

In either case, the net result is a change in the longitudinal profile of the stream bed, such that the headwater gradient is diminished and the critical zone of deposition migrates slowly upstream. Hence that stretch of gold placers, no longer subject to downstream movement, is lengthened, and a paystreak is deposited progressively upstream. The concept thus results that the part of a placer farthest downstream was deposited first and that the formation of the paystreak took place progressively upstream, as a series of overlapping wedges. This mode of paystreak formation is particularly applicable in areas where the local base level of erosion has remained sensibly constant over a long period of time; and such conditions have apparently obtained during certain erosional cycles in parts of interior Alaska.

If a paystreak was derived from a lode located in the headwater part of a valley, and if it was formed in the manner above outlined, it should be expected that most of the placer gold will be formed near, on, or in bedrock. This is actually true for most of the placer streams of Alaska, the gold being found in the lowermost few feet of gravel, on the surface of bedrock, and if the latter is greatly fractured to a depth of as much as 6 feet in bedrock. Some of the early dredge operators in Alaska failed to recognize the depth to which gold can penetrate in bedrock; and as a result of this, and also of inadequate washing in the trommel, some of the old dredging sites are now being reworked at a good profit. The absence of this localization of the gold becomes immediately a reason for searching a valley for uneroded lode sources not in the headwaters, or for postulating a rapidly changing local base-level of erosion during the deposition of the gold, or after a part of it had been deposited. One of the most striking examples of gold that is not concentrated near bedrock, is found in the placer streams which derived their gold from the Tertiary sedimentary reefs, above described.

It is obvious that this idealized mode of placer accumulation, which stresses the lack of geologic simultaneity in the formation of a paystreak, may be modified in many ways, not merely by a succession of erosional cycles, but also by conditions and events that may exist within a single cycle of erosion. The theory, as sketched, applies particularly to placers that accumulate from lodes that are localized in or near the headwater portion of a valley, and many examples of such conditions in interior Alaska could actually be cited. But the bedrock source of gold is not always thus localized, as for example where the locus of a lode system is more or less coincident with a valley, or where mineralized zones occur intermittently, crossing the valley at different places. Likewise there may be present proximate sources of gold, other than bedrock gold, such as auriferous bench gravels of any origin, which are distributed along the sides of a valley, or auriferous gravels or conglomerates which cut across valleys. All such conditions, and combinations of them, tend either to modify or to render entirely inapplicable the idealized concept; and many such examples are known in interior Alaska where the general hypothesis does not apply, even within a single erosional cycle.

Summarizing, it needs to be stressed that no general hypothesis of placer accumulation can be presented. The volume of available debris, derivable from bedrock, is affected by climatological conditions, past and present; and such conditions also control the volume of water formerly, and at the present time, existing in valleys. The character of the alluvial deposits is likewise affected by climatological conditions, as for example in interior Alaska where these deposits are frozen to great depths. The velocities and erosive power of streams, on the other hand, are functions that depend upon many variables, among which are the volume of water, the transported load and the valley gradients. And finally, the valley gradients, though locally influenced by the character of bedrock and other factors, are in large measure controlled by the duration, changes, and accelerations in local base levels of erosion. Some of these data can be deduced or inferred from geologic studies; others can not. Hence, the history and mode of formation of placer deposits in a region constitute a series of individual, yet related problems, which are seldom completely solvable.

THE PROBLEM OF FINENESS

The fineness of lode and placer gold is an economic factor of considerable significance. Gold that is 900 fine, for example, yields a profit 20 percent greater than gold having a fineness of 750; and since many examples could be cited of finenesses of this order, the illustration is by no means overdrawn. In general, therefore, the matter of fineness has been approached from a purely economic rather than a genetic point of view; and thousands of assays have been made of Alaska gold, with few attempts to correlate and to understand these significant data.

The genetic problem of fineness has several aspects, of which the most general has to do with the range and limits of the ratios of gold to silver in all the natural alloys of these metals. A second phase of the problem is concerned with the recognition and explanation of variations in the grades of lode and placer gold, and this veers into and is really a specialized part of the theory of placer genesis. Still another phase of the problem is what might be called a problem of fineness of lower magnitude, dealing with the variations in fineness within individual nuggets, grains, and crystallites of gold-silver alloys; and this in turn leads to a physical-chemical study of free gold.

It has already been shown that artificial alloys of gold and silver form a continuous series of solid solutions, with all possible compositions from pure gold to pure silver. The natural alloys of gold and silver, however, seldom contain more than 40 percent and never more than 60 percent of silver; whereas at the other end of the system, native silver is usually free of gold, and seldom contains more than traces of it. Therefore, it is possible that a miscibility gap exists in the solid state of the gold-silver system, as developed in nature. It has also been shown that the specific volumes of the natural alloys of gold and silver depart materially, and in a reverse manner, from the specific volumes of the corresponding artificial alloys. Hence, it appears doubtful that the natural gold-silver alloys are altogether solid solutions, or, if they are, the presence of a small percentage of base metals in the dross has produced some remarkable atomic readjustments. Moreover, since most geologists believe gold-quartz veins to be of hydrothermal origin, what basis is there for assuming that gold and silver will crystallize in the presence of silica, water, base metals, and mineralizers to produce a solid phase identical with that which solidifies from dry melts of gold and silver alone? And finally, is it not possible that allotrophic modifications of gold and silver may crystallize under the conditions of cooling formulated by geologists? These questions will be answered only by laboratory work on specimens of the natural gold-silver alloys; and such studies will probably have to include the investigation of many physical properties of such alloys, both on macroscopic and microscopic scales, in addition to chemical and thermal analyses.

High-grade placers can be developed by the partial erosion of high-grade lodes, thus making it possible to interpret preexisting bedrock conditions in the light of the present bedrock; yet this condition seldom obtains, because high-grade lodes are rare. On the other hand, high-grade placers may also be produced from low-grade lodes, but under such conditions the life history of the placers is so extended that the original lodes may be largely or completely removed by erosion. At some localities the roots or basal parts of the lodes may still remain, but the contained ores may be quite different from the medial and apical horizons that have been removed. Hence, it is seldom that observations on bedrock lead to a complete understanding of the character and genesis of the preexisting ore deposits that served as the sources of the placers.

Few data have been collected in Alaska that bear upon the character of the eroded lodes, but one generalization has been adduced, partly from theoretical reasons and partly from observed relationships, that seems to bear upon the distribution of fineness in placers. It is probably the usual, rather than the unusual, condition for the fineness of gold to vary in different parts of a lode. Pertinent data on this point are lacking, partly because the depth of many gold mines is less than the thickness of rocks eroded to produce the present placers, and partly because this topic has not received the consideration it could have received in our deep mines. But since the primary ores of the precious metals are known in some mines to give place at depth to base ores, it is a reasonable hypothesis that free gold itself, in the apical horizons of an original ore body, may be of higher fineness than that which occurs at considerably greater depths, as a result entirely of hypogene processes. The apical enrichment of lode gold by supergene processes can hardly be questioned at some localities.

Gold lodes have been either wholly or partly eroded to produce their derived placer deposits. Let it be assumed that the apical portions of lodes contained gold of higher grade than the lower horizons. Then if they have been wholly eroded, and if no enrichment of the gold has occurred during or after the transformation of the lode gold to placer gold, the average fineness of the placer gold should equal approximately the average fineness of the preexisting lode gold. But if the lode deposit has been only partly eroded, as is usually true, then the average grade of the gold in any one paystreak should be higher than that of the gold in the uneroded part of its antecedent lode. Moreover, and regardless of the degree of erosion, it follows that the average fineness of all the gold recovered from existing lodes should be less than that of the average fineness of all placer gold; and this is actually true. It should also follow from these considerations that gold of lower grade could be found in existing lodes than in placers; and this is likewise true, as little or no gold having a fineness of less than 600 has been found in placers, whereas lode gold has been found to have a fineness as low as 400.

In addition to variations in the primary fineness of gold within a preexisting lode system, it is probable, at least in interior Alaska, that a zone of oxidation and enrichment has existed continuously from the time that these lode systems were bared to erosion to the present day. If surficial enrichment within a lode system has operated to increase the fineness of lode gold, then in a country free from glaciation, this has been a continuous process to which all the lode gold was subjected, though perhaps in varying degrees, before it was liberated from its bedrock sources. This process of enrichment may, and in some areas certainly has, operated to produce marked differences in the grades of lode gold and placer gold derived therefrom; but unless this process varies greatly in intensity from one geologic epoch to another, it is improbable that it has been more than a minor factor in producing variations in the grade of the gold within any one paystreak.

One of the best examples known in Alaska of a great divergence between the lode gold and the placer gold derived from it, has been described by the writer[17] in the Nixon Fork district. Here occurs a quartz monzonite of Tertiary age, which has been the bedrock source for gold placers in the streams draining from it; yet the roots of the lodes are still preserved, and are being actively mined as gold lodes. From the records of thousands of ounces of this lode gold, its average fineness is known to be 735, with maximum and minimum values, respectively, of 781 and 715; yet in Hidden Creek, which drains out of the lode area, the maximum, minimum, and mean finenesses are, respectively, 961¼, 892½, and 928 parts gold in a thousand. It should be stressed also that at this particular site the fineness does not increase progressively downstream; and although most of the paystreak that has been mined is underlain by a bedrock of limestone, nevertheless this paystreak extends upstream into the zone of quartz monzonite bedrock. Certainly no better example than this could possibly be found to prove that the gold eroded from the apical part of this lode system was of higher grade than that now being mined in the roots of the lode; but such conditions indicate an enrichment of the alloy in gold in the zone of weathering, before it was liberated from its bedrock source. In other words, as no marked variation of fineness is known within the paystreak, this locality may not be cited as an example of primary differences in the grade of the lode gold.

The general accepted theory has been stated, which pictures the paystreak as a series of overlapping wedges of gold-bearing alluvium, which are progressively deposited upstream during a single erosional cycle. According to this view the downstream end of a paystreak is its oldest, and the upstream end is its youngest part, if the deposition has taken place during a single cycle of erosion. A hypothesis has also been stated, which assumes that the apical part of a gold lode contains gold of higher grade than its lower horizons. Taken together, these two concepts lead directly to the conclusion that the gold of highest grade is likely to be found in the downstream end of a paystreak, and that the grade of the gold may diminish progressively upstream. This relationship actually exists in some placer paystreaks in Alaska, but in others the fineness has been observed to change erratically, or not at all.

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[17] MERTIE, J B., JR *Mineral deposits of the Ruby-Kuskokwim region, Alaska.* U S Geol Surv Bull. 864: 193–194, 229–242 1934

The progressive increase in the fineness of placer gold, in going downstream, has heretofore been explained as due to the removal of silver from gold-silver alloys as a result of solution by cold surface waters, during or after the formation of a paystreak. According to this hypothesis, the gold farthest downstream has traveled a greater distance from its parent lode than the gold farther upstream. Therefore it has suffered the most handling by streams, has been to the greatest degree comminuted, and for both these reasons has been the most vulnerable to solution, Also, it has been longest separated from a bedrock source, and for this reason, too, should have been most affected by solution. This hypothesis is further supported by an experiment performed by McConnell,[18] on some of the placer gold of the Klondike district, in Yukon Territory, Canada. He found that gold shaved from the outer surface of a nugget assayed 60 to 70 parts per thousand finer than gold from the inside of the nugget; and this has been generally accepted as a proof that surface waters dissolve an appreciable amount of silver from gold-silver alloys in a paystreak. Let us look at the supporting data.

It has already been shown that the silver contained in artificial alloys of gold and silver can be completely dissolved by strong inorganic acids, only when the ratio of gold to silver is 1:3 or less; also that if this ratio is greater than 1:1.5, corresponding to a fineness of 400 parts gold in a thousand, no silver will be dissolved. It has also been shown that the solubility of silver in pure water is very slight. But practically all placer gold is of higher grade than 600 fine, and moreover we are dealing with ordinary cold surface waters, instead of strong inorganic acids. Finally, it must be remembered that any gold that has remained undisturbed in the placer paystreaks of interior Alaska since the beginning of Pleistocene time has probably been entirely untouched by water for the last million years, because these alluvial deposits were then, as now, largely frozen.

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[18] McConnell, R. G. *Report on the gold values in the Klondike high-level gravels.* p. 979. Geological Survey of Canada, 1907.

Still other facts have to be considered. The assayer knows that even strong inorganic acids do not readily remove all the silver from large pieces of a gold-silver alloy; and for this reason, a sample of the alloy, after quartation, is hammered flat on an anvil before treatment with nitric acid, in order to present a large surface to solution. Hence, the weak solvents postulated to exist in cold surface waters should affect only the outer layers of grains of placer gold; and for this reason the surficial volume of nuggets and coarse grains of gold, in which solution of silver might occur, is a smaller proportion of the total volume than in small grains of placer gold. It, therefore, follows, insofar as enrichment by solution of silver is concerned, that nuggets and coarse grains of placer gold should be of lower grade than the finely comminuted grains of placer gold. Actually, in any one paystreak, and at any one place in the paystreak, the reverse is usually true. Furthermore, when any appreciable amount of silver is dissolved in the laboratory from a gold-silver alloy, the sample becomes distinctly porous; and if much of or all the silver is removed, the sample becomes very fragile and may even crumble to a powder. Therefore, if solution of silver is actually accomplished by cold surface waters to an extent sufficient to change appreciably the fineness of placer alloys, this process should be reflected in a marked surficial porosity. But this also has not been observed.

As for McConnell's experiment, nothing is proved except that the outer surfaces of certain nuggets were of higher grade than the inner parts. It does not at all follow that this relationship is due to solution of silver by cold surface waters, for either it may have been an original characteristic of the primary lode gold, or, more probably, it was caused by surficial enrichment in the zone of oxidation, long before the gold was liberated from its bedrock source.

As a result of these considerations, the writer is not disposed unreservedly to accept the idea of any progressive change of fineness in a placer paystreak, as a result of solution of silver from gold-silver alloys by the action of cold surface waters. But it must be admitted that the alternate hypothesis is also unproved. In the first place it rests upon another hypothesis regarding the vertical distribution of different grades of gold in preexisting and present lodes. And secondly, it rests upon physical-chemical data that assume an essential identity, or at least the great similarity, of artificial and natural alloys of gold and silver, in so far as their chemical reactions are concerned. Hence, additional geologic, mining, and chemical data will be needed to prove or to disprove the hypothesis above outlined. If, for example, the emplacement of a granitic body long antedated the formation of its associated lode deposits, and if a period of diastrophism had intervened between these two processes, the apex of the intrusive mass and the apex of the mineralized zone would not necessarily correspond. And if diastrophism had occurred after either or both of these processes had occurred, the present cropping of an intrusive might correspond to neither of these antecedent apices.

Mining and chemical data are required, most of all to learn the three-dimensional variations in fineness that may exist in present gold lodes. Assays, both of bulk samples and of individual grains, should be made of uncontaminated samples of free gold taken from different horizons in lodes; and for this purpose assays of run-of-mine bullion may or may not suffice, depending upon the methods employed in recovering the gold. Assays, for example, of bullion recovered by cyanidization would certainly be useless. Complete chemical analyses should also be made, in order to learn the character and quantity of the metals in the dross; and for this purpose, even amalgamated free gold would not be serviceable.

Finally, the physical and physical-chemical properties of natural gold-silver alloys need to be studied, in order to learn how they differ from those of the corresponding artificial alloys. One of the most important problems of this work should be a complete physical and chemical examination of individual grains and nuggets of natural gold. According to Raydt's equilibrium diagram, it is possible, if the solidification of gold took place rapidly enough, that individual crystals of gold could be zonally grown, in the manner of the plagioclase feldspars. If this occurs, and if his equilibrium diagram applies to natural alloys, the outer zones of crystallites should be lower in gold than the cores. Such a condition could hardly influence materially the range of fineness in a placer paystreak, as it would be a microscopic phenomenon, of a lower order of magnitude. But the investigation of this and related phenomena is equally a part of the general problem of fineness.

CHEMISTRY.—*The fungistatic and fungicidal action of certain organic sulphur compounds.*[1]

EDWARD L. EVERITT, Georgetown University School of Medicine, and M. X. SULLIVAN, Chemo-Medical Research Institute, Georgetown University.

Both bacteria and molds are in general useful to man, as for example in decomposing plant and animal debris, which, if allowed to accumulate, would sooner or later be to man's detriment. In both fields, certain forms have become parasitic on man or on the fruits of the field on which man depends directly or indirectly for food and clothing. The part that bacteria may play in the production of pathological condition has become common knowledge and has long been under study by the bacteriologist and the practitioner of medicine.

On the other hand, the relation of common molds to health and disease has been given less attention and study since, unlike the bacteria, molds do not in general cause acute and killing diseases, in man at least. However, Kuchenmeister (1857) lists 14 species of fungi that invade the skin, hair, nails, lungs, or mucous membranes. In the list are included *Tricophyton tonsurans*, which invades the hair follicles, and several species of *Aspergillus*, which infect the auditory duct, finger nails, toe nails, etc. Also ringworms caused by fungi of the *Tricophyton* or *Microsporum* families are often met with in man.

In medical practice attention is often called to Moniliae, fungi that invade the mucous membranes, especially of the mouth. Among the diseases of man attributed to this class of fungi are thrush and sprue. There is some suggestion also that fungi, at times at least, may be involved in such allergic conditions as asthma and hay fever. Thus, Prince, Selle, and Morrow (1935) report findings that indicate that molds may play a causative role in some cases of asthma and hay fever, while Brown (1936) considers that hypersensitiveness to fungi must take its place along with sensitization to pollens, animal epidermis, food, and bacteria in the causation of bronchial asthma, eczema, perennial hay fever, and other allergic conditions.

Since molds may destroy the necessary fruits of the field, causing rots of various kinds, and may also invade the skin, the hair, and lungs of man and are incriminated in certain forms of dermatitis, ringworms, actinomycosis of the lungs, loss of hair in some cases, and occasionally in certain allergics, whatever can be found about the metabolic processes and especially about means of preventing them

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[1] The data in this paper are taken from the dissertation presented by Edward L Everitt in partial fulfillment of the requirements for the degree of Doctor of Philosophy, Georgetown University, 1937 Received January 20, 1940

from getting a foothold on plants, animals, or man would be decidedly worth while.

It is well known that molds and bacteria may be killed or inhibited in their growth by drying, heat, light, pressure, and by various chemicals. Chemical substances that kill are known as fungicides or bactericides, while those that simply inhibit growth are called fungistatic or bacteriostatic. Some of the chemical compounds used in the prevention of the growth of bacteria and molds are silver nitrate, mercuric chloride, iodine, phenol, cresol, benzoic acid, alcohol, and various simple sulphur compounds. Among the sulphur compounds used are carbon disulphide, hydrogen sulphide, sodium thiosulphate, flowers of sulphur, and colloidal sulphur. Lime and sulphur mixtures have been used for years to prevent the growth of fungi on plants and trees.

Our interest in the possibility of inhibiting the growth of molds that invade man was aroused by results obtained in a study of the changes brought about by certain wilt-producing organisms In a study of acid-base and oxidation-reduction phenomena, it was noted that sodium thiosulphate added to the medium considerably reduced the growth of the molds. This finding suggested a trial of various organic sulphur compounds because elemental sulphur had long been in use in medical practice in ointments for eczema and various skin conditions and parasitic skin infections, and sulphur baths have long been believed to have medicinal value. A direct bearing on the relation of sulphur to fungi is the work of Lynch (1933), who reports the successful use of a sulphur ointment in the treatment of an *Aspergillus* infection in a scalp lesion caused by the bite of the red bug (*Leptus*), and the review of Roark and Busbey (1935), who list a number of organic sulphur compounds of high value as insecticides.

As pointed out by Roark and Busbey, sulphur in various forms and combinations is one of the most valuable and widely used insecticides and fungicides. In the form of elemental sulphur it is applied to fruit trees and ornamental plants both as a dust and in suspension in water for combating red spiders and fungous diseases.

We had on hand a large number of organic sulphur compounds made or secured in a general study of the relation of sulphur and sulphur compounds to health and disease. Some of these we hoped would be of value in medical and agricultural practice.

Accordingly, some 50 sulphur compounds were tested for their fungicidal action in vitro. The molds used were *Fusarium oxysporum* and *F. lycopersicum*, which cause, respectively, wilt of potato plants and tomato plants; *Aspergillus fumigatus*, which invades the ear of man and occasionally the lungs; *Aspergillus niger*, which spoils foodstuffs and like *fumigatus* may invade man; and the *Penicillium* of Fleming, which according to Reid (1935) generates a material toxic to bacteria. The culture media used and the procedure employed for testing the inhibitory action of the various compounds are detailed in the following sections.

The culture medium—The synthetic culture medium used in this investigation was the same as used by Anderson, Everitt, and Adams (1933) in their study of the carbohydrate metabolism of *Fusarium oxysporum*, which causes wilt of potatoes. It was first used by Tochinai (1920) to study the carbohydrate metabolism of *Fusarium lini* The composition of the medium is as follows:

Ammonium nitrate	1 00 gm
Magnesium sulphate	0 25 gm
Monopotassium phosphate	0 50 gm
Glucose	20 00 gm
Water to make	1,000 cc

In the present work, to 100-cc portions of this culture medium in 250-cc Erlenmeyer flasks various quantities of the organic sulphur compounds were added, and the flasks were plugged with cotton and sterilized at 15 pounds pressure for 20 minutes Control flasks containing the medium without addition of the sulphur compounds were sterilized in a similar manner

Inoculation of the medium—The stock medium for the development of the molds was Sabouraud's dextrose agar described in Difco Manual, ed. 5, 1935. Spores collected from the agar slants were suspended in sterile distilled water, and 1 cc of the spore suspension was added to each culture flask by means of a sterile pipette The sulphur compounds tested are listed in Table 1

Compounds (1)–(13) were obtained from Dr H L Haller, Bureau of Entomology and Plant Quarantine, U. S Department of Agriculture The remaining compounds were at hand at Georgetown University

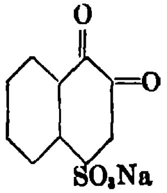
Inasmuch as most of these compounds were ineffective, that is, did not inhibit the growth of the molds, the formulas are not given here. Those compounds that were effective will be discussed in detail and their formulas will be given later.

With *Fusarium oxysporum* and *F. lycopersicum* used as test fungi, only a few of the compounds listed in Table 1 inhibited or stopped growth The inhibitors were Nos. (10), (11), (33), (34), (36), and (47) These compounds inhibited growth for a period varying from 4–15 days, after which time the organism slowly developed. These compounds could be utilized as fungistatic material and might have application in medical practice, in external application. One compound, (24), the disulphide of ortho-thioaminophenol, absolutely prevented growth of *Fusarium oxysporum* but allowed a slight and delayed growth of *Fusarium lycopersicum* with increase in growth after the nineteenth day. Colloidal sulphur, (33) (sulphur diasporal), was labeled as containing 10 mg of S in 2 cc. One cc was added to 100 cc of the culture medium. Colloidal sulphur (sulisocol) was labeled as 2 cc containing 20 mg of sulphur. One-half of 1 cc was added to 100 cc of culture media. Both types of sulphur in a colloidal complex markedly inhibited the growth of the molds, even at concentrations calculated to be 50 mg per liter Since a question arose as to whether the inhibiting action was due to the sulphur as such or to the changes in the reaction of the medium, the study of the inorganic sulphur in the protective colloid solution was put aside for later development. Two compounds, mercaptobenzothiazole and phenylbenzothiazole, allowed no growth whatsoever of the two molds mentioned above when present in the culture media at the concentration of 5–10 mg in 100 cc of solution. Because a number of the organic sulphur compounds were found effective in inhibiting or utterly preventing the growth of the two molds, the experiment was extended to other molds as given in Table 2.

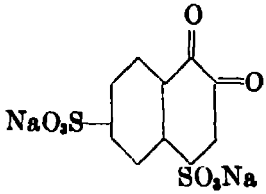
TABLE 1.—SULPHUR COMPOUNDS STUDIED FOR FUNGICIDAL AND BACTERICIDAL PROPERTIES

(1) Phenothiazine-6-carboxylic acid chloride
(2) 6-Acetyl-phenothiazine
(3) Phenothioxine
(4) Phenothiazine
(5) Tetrathiopentone
(6) Cuprous methylxanthate
(7) Cuprous isoamylxanthate
(8) Chlorbenzoketothiazine
(9) 4-Chloro-2-nitrophenyl thioglycolic acid
(10) Phenyl thioarsenite
(11) 4-Chloro-2-nitrophenyl sulphur amine
(12) 4-Chloro-2-nitrophenyl sulphur bromide
(13) Bis(2-nitrophenyl) disulphide
(14) Thioacetamide
(15) Mercaptobenzothiazole
(16) Phenylbenzothiazole
(17) Sodium diethyldithiocarbamate
(18) Diethyl thiourea
(19) Thiourea
(20) Disulphide of thiotyrosine
(21) Dithiosalicylic acid
(22) Phenylthioglycolic-ortho-carboxylic acid
(23) Benzidine sulphonate
(24) Disulphide of ortho-thioaminophenol
(25) Cysteic acid
(26) Thiazolidine carboxylic acid
(27) Formyl-dl-cystine
(28) S-carboxymethyl-cysteine
(29) Cystineamine hydrochloride
(30) Thiazolidine hydrochloride
(31) Thiobarbituric acid
(32) Benzyl disulphide
(33) Colloidal sulphur (diasporal) 2 cc = 10 mg
(34) Colloidal sulphur (hyposols or sulisocol) 2 cc = 20 mg
(35) Sulphanilic acid
(36) 1,2 Naphthoquinone-4-sodium sulphonate
(37) 1,2 Naphthoquinone-4-6-sodium disulphonate
(38) Sodium alizarine sulphonate
(39) Tropaolin 000
(40) Congo red
(41) Bromcresol green
(42) Methyl orange
(43) Cresol red
(44) Bromphenol blue
(45) Strychnine sulphate
(46) Thymol blue
(47) Prontylin (Winthrop)
(48) Trional
(49) Sulphonal
(50) Cystine
(51) Sulpharsphenamine

An interesting effect of chemical constitution on the growth of the molds was exhibited by compounds (36) and (37), namely, 1, 2 naphthoquinone-4-sodium sulphonate and 1, 2 naphthoquinone-4-6-sodium disulphonate, with the formulae—



and



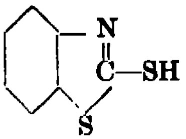
The 1, 2 naphthoquinone-4-sodium sulphonate had marked power of inhibiting the growth of the molds, while the 1, 2 naphthoquinone-4-6-sodium disulphonate was an excellent stimulator of growth. These findings are in harmony with the early work of Ehrlich and Herter (1904), who found the sodium salt of the 1, 2 naphthoquinone monosulphonic acid to be toxic. Since these compounds are relatively expensive and since the work of Ehrlich and Herter, especially that of Herter (1905), indicated that the 1, 2 naphthoquinone-4-sodium sulphonate was toxic to animals, no further attention was given to the compounds as fungistatic or fungicidal substances for use in medical or agricultural practice.

Of the compounds studied in relation to the growth of the molds in vitro,

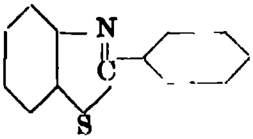
TABLE 2.—STUDY OF THE MOST PROMISING SULPHUR COMPOUNDS HAVING FUNGISTATIC AND FUNGICIDAL PROPERTIES WHEN ADDED TO 100-CC CULTURE MEDIUM

Compound No.	Amount used	F. oxysporum	F. lycopersicum	A. niger	A. fumigatus	Penicillium of Fleming
10	*mg* 12.5	First growth in 15 days, slow thereafter	No growth in 25 days	No growth in 11 days, slight in 25 days	No growth in 15 days, slight in 25 days	Very few spores in 15 days, slow thereafter
11	12.5	First growth in 15 days	First growth in 15 days	No growth in 11 days, slight in 15 days	No growth in 25 days	A few spores in 15 days, slight thereafter
15	3.0	Growth in 8 days, becoming heavy	Slight growth in 8 days, becoming heavy	Good growth in 8 days, very few spores	No growth in 25 days	Very slight growth in 25 days
15	5.0	No growth at any time	No growth at any time	Slight growth in 8 days, no spores	No growth in 25 days	No growth in 15 days, a few spores in 25 days
15	10.0	No growth	No growth	No growth	No growth	No growth
16	3.0	Slight growth in 8 days, becoming heavy	Slight growth in 8 days, becoming heavy	Heavy growth in 8 days, with spores	Slight growth in 11 days, slowly increasing	Slight growth in 8 days
16	5.0	No growth	No growth	Slight growth in 8 days	No growth in 25 days	Slight growth in 8 days
16	10.0	No growth	No growth	No growth in 25 days	No growth	No growth in 25 days
36	12.5	No growth in 11 days, some spores in 15 days, slowly increasing	No growth in 25 days	Good growth in 8 days	No growth in 25 days	No growth in 15 days, slight growth and a few spores in 25 days
47	10.0	Slight growth in 4 days	Slight growth in 8 days			
47	25.0	No growth in 4 days, slight growth in 12 days	Slight growth in 7 days	Slight growth in 7 days	Slight growth in 7 days	

number (15), mercaptobenzothiazole, and number (16), phenylbenzothiazole, were the most effective Their chemical constitution, respectively, is—



and



Of these two, mercaptobenzothiazole was on hand in plentiful supply, so some attention was paid to it from chemical and clinical viewpoints and to its possible toxicity toward animals As may be seen from its formula it is an organic sulphur compound containing nitrogen and an (SH) group. This compound, which is cheap and readily available, was first made by Hofmann (1887) and has been used in the rubber industry as an accelerator of vulcanization for a number of years Its use for such purposes seems to have been first suggested by Bedford and Sebrell (1921) It is soluble in alcohol, chloroform, and benzol but is not very soluble in water It is sufficiently soluble in water, however, to be used as a germicide. It is more soluble as a sodium salt and is rather soluble in sodium bicarbonate

As judged by lack of growth for 50–60 days in the case of *F oxysporum*, *F. lycopersicum*, and *A. fumigatus*, the compound has marked fungicidal power In the case of *A. niger* and *Penicillium* of Fleming, mercaptobenzothiazole showed strong fungistatic activity, since no growth occurred until after a period of 25 days Without prejudice as to whether a compound can be found that is fungistatic or fungicidal toward molds in general, it can be said that with the molds studied by us mercaptobenzothiazole had marked fungicidal or fungistatic activity

Roark and Busbey (1935) state that mercaptobenzothiazole in concentration of 0 01 to 0.10 percent was effective in controlling a fungus living on wood and that it has been used in controlling aphids and mosquito larvae. Davis (1930) reported that this compound had little if any toxicity He injected an aqueous solution of it into guinea pigs and a total injection of 14 5 mg in 20 days did not produce any injurious effects on the animals Medical examination of the men working with mercaptobenzothiazole over a period of years in the Goodyear Tire & Rubber Co did not show any toxic conditions or dermatoses. In a recent personal communication, Dr. Davis (1939) reiterates the conclusion that the compound has shown no toxic action on men working with it in the vulcanization of rubber.

We have given 20–100 mg of the mercaptobenzothiazole by mouth to guinea pigs weighing 400 grams with no gross evidence of toxicity and have injected 20 mg in aqueous suspension intraperitoneally into a 200-gram guinea pig with no effect on his activity, appetite, or general well-being. Dr. William B. Wardrop, of Washington, D. C., found the mercaptobenzothiazole practically as effective toward "athlete's foot" as salicylic acid. The various sulphur compounds were also tested for their bactericidal and bacteriostatic properties. The findings will be detailed in a subsequent paper.

SUMMARY

About 50 organic sulphur compounds were tested for their fungistatic and fungicidal action.

The molds used were the wilt-producing *Fusarium oxysporum* and *F. lycopersicum*, the pathogenic *Aspergillus fumigatus*, the common *Aspergillus niger*, and the *Penicillium* of Fleming.

Fungistatic activity was manifested by phenylthioarsenite, 4-chloro-2-nitrophenyl sulphur amine, 1, 2 naphthoquinone-4-sodium sulphonate, and prontylin or sulphanilamide.

Fungicidal activity was manifested by mercaptobenzothiazole and phenylbenzothiazole.

The most effective compound was mercaptobenzothiazole, which inhibited the growth of the molds in concentration of 50 to 100 parts per million. This compound is cheap and readily available.

The investigation deals only with in vitro tests, and no conclusion can be drawn as yet as to the therapeutic application of the various compounds. Preliminary toxicity tests on guinea pigs with both oral and intraperitoneal application indicate that mercaptobenzothiazole, the most effective fungicidal compound, has little if any toxicity.

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PALEOBOTANY.—*Additions to the Pensauken flora.*[1] EDWARD W. BERRY, Johns Hopkins University.

In 1935 the writer in collaboration with Alfred C. Hawkins published[2] an account of the plants found in the Pensauken formation in Middlesex County, N. J. From time to time Dr. Hawkins has sent in small amounts of additional material, which I have not had time to study thoroughly until the past summer. The material is in the same limonitic, coarse, micaceous sandstone as the original specimens, and the preservation of the plants leaves much to be desired in the way of details of venation.

The forms identified in the later collections are the following: *Cebatha carolina, Epigaea repens, Fagus americana, Nyssa sylvatica, Salix humilis*, and *Viburnum alnifolium*. Among these the *Epigaea, Fagus*, and *Nyssa* are additions to the Pensauken flora. They add little in the way of interpretive evidence of Pensauken time.

Epigaea repens Linnaeus

A single relatively small leaf, very coriaceous and with the margins inclined to be revolute. So far as I know the trailing arbutus has not heretofore been found fossil In modern times its range is from Newfoundland to Florida in the Coastal Plain, usually on sandy soil It occurs also beyond the limits of this province

Fagus americana Sweet

This species, represented by leaves or fruits, is exceedingly abundant in the Pleistocene of southeastern North America, having been recorded from 11 States from Massachusetts on the north to Mississippi on the south, chiefly in river terraces in the Coastal Plain province, although also recorded from cave deposits in Pennsylvania and interglacial deposits in West Virginia.

Nyssa sylvatica March

A typical leaf of this species. Stones of this species have been recorded from the Pleistocene of both Maryland and the District of Columbia. In the modern flora it ranges, in rich, mostly swampy soil, from Maine and Ontario to Florida and Texas.

There is some confusion among our recent species as well as among the Pleistocene records. Two species, *Nyssa caroliniana* Poir and *Nyssa uniflora* Walt., are recorded from the Bridgeton sandstone of southern New Jersey and stones referred to *Nyssa biflora* have been recorded from the Pleistocene of New Jersey (Fish House), Maryland, Virginia, North Carolina, and Alabama. Probably some of these should really be referred to *Nyssa sylvatica.*

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[1] Received October 11, 1939

[2] BERRY, EDWARD W., and ALFRED C. HAWKINS, *Flora of the Pensauken formation in New Jersey.* Bull. Geol Soc. Amer. **46**: 245–252. 1935

BOTANY.—*A nomenclatorial note on* Pseudoperonospora.[1] G. R. Hoerner, U. S. Bureau of Plant Industry. (Communicated by John A. Stevenson.)

Miyabe and Takahashi,[2] in describing a new species reported for the first time on hops, state:

> This fungus with its dichotomously branched conidiophores and with its conidia germinating by zoospores shares the characters of two genera *Peronospora* and *Plasmopara*, and may form an intermediate genus together with the downy mildew fungi of cucumber and *Celtis*. In 1901, Berlese[3] created a new subgenus, *Peronoplasmopara*, in the genus *Plasmopara* and placed under it *Peronospora cubensis* Berk. et Curt., and *Peronospora Celtidis* Waite. Rostowzew[4] reported in 1903 a detailed account of his study of different species of the Peronosporaceae, but especially of *Peronospora cubensis* B et C., on which he founded a new genus *Pseudoperonospora*, apparently without knowing the above mentioned work of Berlese.
>
> In 1904, Clinton[5] made a critical study of the cucumber mildew and came to a similar conclusion in regard to the recognition of its generic position. But regarding Berlese's subgenus, *Peronoplasmopara*, because of priority of publication, and also because it was given definite descriptive characters as deserving preference over Rostowzew's rather indefinite *Pseudoperonospora*, Clinton elevated *Peronoplasmopara* to generic rank and included under it two species, *Peronoplasmopara cubensis* (Berk. et Curt.) Clint., and *Peronoplasmopara Celtidis* (Waite) Clint
>
> In the present paper, we have adopted Clinton's view and name our fungus *Peronoplasmopara Humuli* Myb et Tak, thus adding another species to this interesting genus.

However, on the basis of priority, if present generally accepted rules of nomenclature are followed, it appears that Rostowzew's name for the genus is still valid. In view of the characteristics assigned to the genus *Pseudoperonospora* and the validity of this genus name, it seems necessary to assign this generic designation to three species that have not hitherto been transferred to it although they clearly belong there. The following new combinations are therefore proposed:

Pseudoperonospora cannabina (Otth), n. comb.

Peronospora cannabina Otth, Mitt. Naturf. Ges. Bern, 1868, pp. 37–38. 1868.

Peronoplasmopara cannabina (Otth), Peg. Atti Accad Naz. Lincei 114 (ser. 5, 26): 620. 1917

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[1] Technical Paper No. 327, Oregon Experiment Station Received December 21, 1939

[2] Miyabe, K, and Takahashi, Y Trans Sapporo Nat Hist Soc. 1: 153. 1905–1906

[3] Berlese, A N Riv Pat Veg. 9: 123–126 1901.

[4] Rostowzew, S J Flora 92: 405–430. 1903

[5] Clinton, G P. Rpt Connecticut Agr Exp Sta. 1904: 329–362. 1905.

Pseudoperonospora elatostemae (Togashi and Onuma), n. comb.

Peronoplasmopara elatostemae Togashi and Onuma, Bull. Imp. Coll. Agr. and For Morioka 17: 2, fig. 1. 1934.

Pseudoperonospora portoricensis (Lamkey), n. comb.

Peronoplasmopara portoricensis Lamkey, *in* Stevens, Mycologia 12: 52. 1920.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE ACADEMY

358TH MEETING OF THE BOARD OF MANAGERS

The regular monthly meeting of the Board of Managers of the Academy was held in the Holmes Room of the Cosmos Club, January 12, 1940. In addition to the customary reports of the standing committees the Treasurer presented and discussed an epitome of his annual report. He showed that despite the publication of the "Red Book" the balance for the year's operations is only slightly red.

The report of the special Committee on Clerical Assistance for the Board of Editors, of which John A. Stevenson was chairman and H. E. Ewing and Herbert Friedmann members, was read by Secretary N. R. Smith in the absence of the committee The report recommended discontinuance of the title "Editorial Assistant" but expressed no opinion on the question as to whether the Board of Editors should be granted or denied assistance. Following a general discussion on the advisability of permitting the editors to employ clerical assistance, the report was accepted

The Custodian of Publications, W. W. Diehl, presented a request from the Peiping National Library for a free subscription to the Journal for the current year. This institution pleaded that the continued hostilities in China which had driven it to Yunnan made it impossible to renew its subscription. The Board instructed the custodian to grant the request for the year 1940.

The subcommittees on awards of Certificates of Merit for scientific achievement reported as follows:

E. A. Goldman, chairman of the Committee for the Biological Sciences, presented the decision of his committee, which selected Herbert Friedmann to receive the Award for Achievement in the Biological Sciences for his work on the parasitic cowbirds and cuckoos and for his studies of avian taxonomy and geographic distribution. Dr. Friedmann was born in New York City on April 22, 1900. He received his B S. degree from the College of the City of New York in 1920 and his Ph.D. from Cornell University in 1923. After a three-year National Research Council fellowship he taught first at Brown University, then at Amherst College. In 1929 he succeeded Robert Ridgway as curator of birds in the U. S. National Museum, a position he still holds.

H. L. Curtis presented the decision of the Committee on the Engineering Sciences, of which he was chairman. For the award in this field Paul Albert Smith was selected for his contributions to topographic surveys of the ocean bottom along the eastern coast of the United States. Mr. Smith was born at Rising Sun, Iowa, January 9, 1901. He received his B.S. degree at the University of Michigan in 1924. In August 1924 he joined the staff of the U. S. Coast and Geodetic Survey and has remained with that organization.

H. D. Miser presented the decision of the Committee for the Physical Sciences, of which **J. F. Couch** was chairman. For this award **Wilmot Hyde Bradley** was selected for his investigations of varves in the Green River formation of Wyoming and his contributions to the geology of abyssal sediments. Dr Bradley was born at New Haven, Conn., April 4, 1899. He received his Ph.B. degree at Yale University in 1920 and his Ph D. in 1927. During his summer vacations he worked as field assistant in the U. S. Geological Survey, and at the completion of his academic work he joined the staff of that organization, where he has remained

After a discussion of the age limit, in which it was agreed that investigators eligible for honors are those who have not attained their forty-first birthday at the close of the year for which the awards are made, the Board voted without division to award Certificates of Merit to the above three nominees. Following a brief consideration as to how the Certificates evidencing this honor accorded by the Academy were to be presented—which was without conclusion—the Board adjourned to resume its discussions informally over a surprise buffet supper provided by the retiring President.

The attendance of Board members follows:

Present		*Absent*	
C E Chambliss	(Pres)	O S Adams	(Rec Sec)
N R Smith	(Corr Sec)	J F Couch	(Board Member)
H. G Avers	(Treas)	Neil M Judd	(Board Member)
F G Brickwedde	(Board Member)	H. C Fuller	(Board Member)
J H Hibben	(Board Member)	H S Graves	(nonresident V P)
G Steiner	(Board Member)	R B Sosman	(nonresident V P.)
Henry B Collins, Jr	(An)	W B Bell	(B)
A Wetmore	(G)	B H Nicolet	(C)
H D Miser	(Gl)	A H Clark	(En)
W A Dayton	(F)	Fred O Coe	(M)
H L. Curtis	(Ee)	Allen C Clark	(H)
H. L. Wittemore	(Me)	G F Gravatt	(B)
E W Price	(Hl)	Aleš Hrdlička	(An)
F. D. Rossini	(Sr Ed)	P C. Whitney	(E)
W. W. Diehl	(Custodian)	L A Rogers	(Ba)
		Wm Bowie	(Ml)
		J H Dellinger	(R)

In addition to the above members there were present by invitation **F. M. Setzler**, chairman of the Meetings Committee; **E. A. Goldman**, chairman of the Subcommittee on Awards for the Biological Sciences; and the editors, **C. L. Gazin** and **J. H. Kempton**.

SCIENTIFIC NOTES AND NEWS

The Department of State has notified the Academy that the Eighth American Scientific Congress will be held in Washington, D.C., from May 10 to 18, 1940, under the auspices of the United States Government. The Secretary of State has appointed an organizing committee composed of government officials and distinguished scientists. Dr. **Alexander Wetmore**, Assistant Secretary of the Smithsonian Institution, is the Secretary General of the Congress and the Secretary of the Organizing Committee. The Congress will be divided into 11 sections covering the various disciplines. The chairmen of these sections are as follows:

1. *Anthropological Sciences*.—HERBERT J. SPINDEN, Brooklyn Museum
2. *Biological Sciences*.—EDWIN G. CONKLIN, Princeton University
3. *Geological Sciences*.—T. WAYLAND VAUGHAN, Geological Society of America
4. *Agriculture and Conservation*.—HUGH M. BENNETT, U. S. Soil Conservation Service.
5. *Public Health and Medicine*.—THOMAS PARRAN, U. S. Public Health Service.
6. *Physical and Chemical Sciences*.—LYMAN J. BRIGGS, National Bureau of Standards.
7. *Statistics*.—STUART A. RICE, Central Statistical Board.
8. *History and Geography*.—CLARENCE H. HARING, Harvard University.
9. *International Law, Public Law, and Jurisprudence*.—JAMES BROWN SCOTT, Carnegie Endowment for International Peace.
10. *Economics and Sociology*.—HAROLD G. MOULTON, Brookings Institution.
11. *Education*.—NICHOLAS MURRAY BUTLER, Columbia University.

Obituary

HARVEY (WILLIAMS) CUSHING, master-surgeon, neurologist, physician, critical investigator, medical bibliophile, inspiring teacher, littérateur, artist, died at New Haven, Conn., on October 7, 1939. Born in Cleveland, Ohio, on April 8, 1869, the ninth child in his family, he became the fourth in a line of doctors.

From school in Cleveland he went to Yale College (A.B., 1891) and then to the Harvard Medical School (A.M. and M.D., *cum laude*, 1895). After a surgical internship at the Massachusetts General Hospital, he went to Baltimore in 1896 as junior assistant in the surgical service of Halsted at Johns Hopkins Hospital. During 1900–1901 he studied abroad under Kocher and Kronecker in Berne, Mosso in Turin, and Sherrington in Liverpool.

After his return to Baltimore Dr. Cushing became neurosurgeon and then associate professor of surgery at Johns Hopkins. In 1912 he went to Boston as Mosley professor of surgery at Harvard and surgeon-in-chief to the Peter Bent Brigham Hospital. From 1915 to 1919 he saw service in France, during which time he became senior consultant in neurosurgery of the American Expeditionary Forces. Upon reaching the hospital retirement age of 63 in 1932, Dr. Cushing gave up his work in Boston and accepted appointment as the Stirling professor of neurology at Yale, which chair he held from 1933 to 1937.

Dr. Cushing's writings, as compiled at the time of his seventieth birthday, number 318 items, largely in the fields of neurosurgery, neurophysiology, endocrinology, and medical history. He was perhaps more widely known as the author of the Pulitzer prize winner *The Life of Sir William Osler* (1925).

Dr. Cushing was a member of many scientific societies and served as president of the American Society of Clinical Surgery (1921), the American College of Surgeons (1922), the American Neurological Association (1923), and the American Surgical Association (1927). Honors came to him in profusion, culminating in 1938 with the degree doctor of science, "honoris causa," from Oxford.

With Dr. Cushing surgery of the brain became for the first time scientifically established. By nature he was a perfectionist, and his accomplishments seemed to flow from his extraordinary capacity for sustained work. Of him truly it may be said that he was in all that he attempted greatest of the great.

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

VOL. 30   APRIL 15, 1940   No. 4

PALEONTOLOGY.—*Mammals and land bridges.*[1] GEORGE GAYLORD SIMPSON, American Museum of Natural History, New York. (Communicated by C. LEWIS GAZIN.)

It was well known to the ancients that different regions of the earth were characterized by different sorts of animal life. The Roman emperors seeking all manners of beasts for their diversions knew that they must send to various countries each inhabited by characteristic animals. Later, when European travelers began to penetrate the far reaches of the earth, among the first questions asked them was what peculiar creatures inhabited the deserts of Tartary or the jungles of Ethiopia. Cartographers delighted in putting pictures of native animals on their maps, and their efforts to amaze and to embellish produced the first zoogeographic charts. Generations secure in the belief in the creation of things as they are seldom sought any explanation of the differences in fauna between one region and another, and few men obscurely guessed that this might be the outcome of a shifting history rather than the static result of divine command.

The rise of science in its modern form found here a whole series of fascinating problems ready to hand. From a descriptive point of view the main outlines of the present distribution of mammals were long since correctly sketched, and now almost all the details are also known. Confident that the processes of nature are orderly and can be summarized by general theories and explained by general principles, the students of the nineteenth century began the attempt to deduce from the present faunal distribution the historical sequence that led to it. In this new field of inference many blunders were made (and we are surely still making some) because of the lack of historical documents. On this basis alone, the history really can not be deciphered, any more than one could reconstruct the political history of Europe from the present boundaries of its nations if all actual records of the past were destroyed. Here the paleontologist came to the rescue. His discoveries are the historical documents of animal distribution. They have solved many problems in this field and at the same time they have revealed many others as yet unsolved.

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[1] Address delivered before the Washington Academy of Sciences, February 15, 1940. Received February 9, 1940.

Among the plainest inferences from the study of recent mammals is the fact that some of them have been able to cross regions that are now impassable to them. Aquatic animals have somehow traversed areas now dry land, and land animals have gone from one area to another now isolated by a barrier of water. The paleontologist was called on to reveal how such movements were possible and when and under what conditions they occurred.

Now geologists became vitally interested. Caring nothing about the distribution of animals as such, they care a great deal about the past distribution of land and sea, the evolution of climates, the rise and fall of connections between the continents, and other problems that are involved in or that depend on paleontological studies of distribution. Research in this field constantly assumes new aspects and touches new fields of knowledge until from being a curiously specialized and abstruse detail it has become vital for work in several different sciences and has acquired importance and meaning for anyone who takes any intellectual interest in the world in which he lives.

When I undertook to discuss this subject, it was my first intention to take up the various theoretical land bridges from one continent to another and to summarize the evidence for and against each one in order to produce a historical account of where and when such bridges have existed. It soon became apparent that such an account, if it were to have any value, would involve a mass of detail that would, indeed, be of interest only to specialists in this field. It also became evident that relatively few such specialists have risen above this mass of detail to make a conscious survey of the general principles involved and of the basic assumptions underlying their studies. Such a general survey is, then, not only of wider interest but also fresher and more needed in the present stage of study.

To review all the broad problems and principles in one paper is a manifest impossibility, and attention will be directed to two aspects on which it now seems possible and useful to make some suggestions. The first is the broadest problem of all in this field, the general way in which land mammals tend to become distributed and in which their distribution tends to change in time. The second is more particular: the different types of migration routes between major land areas, the way in which one type or another can be inferred from the faunal evidence, and the effect that a given type has on the faunas that use it. In order to lend reality to these abstractions and to point out some further promising leads for research, one specific example of

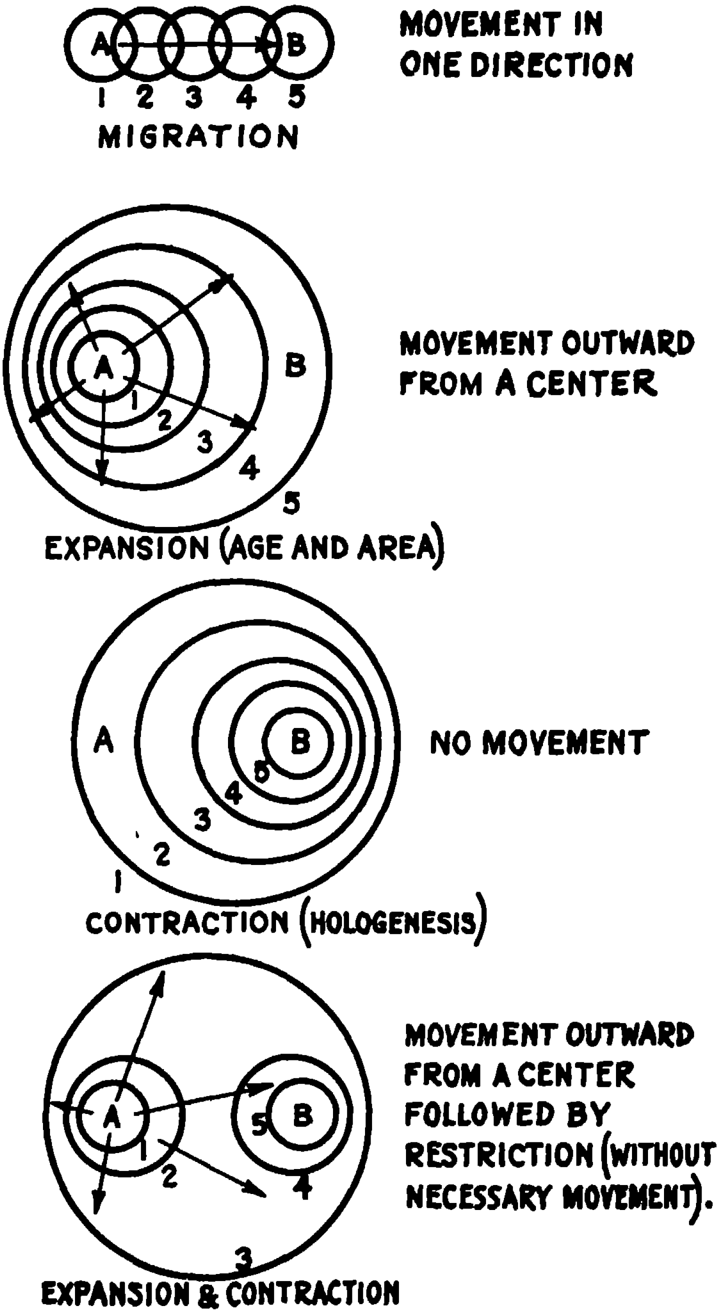
A
B
1 2 3 4 5
MIGRATION
MOVEMENT IN ONE DIRECTION
A
B
1
2
3
4
5
EXPANSION (AGE AND AREA)
MOVEMENT OUTWARD FROM A CENTER
A
B
5
4
3
2
1
CONTRACTION (HOLOGENESIS)
NO MOVEMENT
A
B
1
2
3
4
5
EXPANSION & CONTRACTION
MOVEMENT OUTWARD FROM A CENTER FOLLOWED BY RESTRICTION (WITHOUT NECESSARY MOVEMENT).

Fig 1 —Diagram showing various theoretical explanations of the spread of a group of mammals from one place to another. The given facts are that the group occurs at both A and B and is known at B later than at A. The numbered circles represent the limits of distribution of the group at successive times, from 1 to 5.

the rise of a migration route between continents is then taken and what happened to the continental faunas as a consequence is briefly considered.

TEMPORAL PATTERNS OF MAMMALIAN DISTRIBUTION

We commonly speak of changes in mammalian distribution as being caused by migration and extinction. "Migration" suggests a trek from one area into another or periodic movement back and forth between two regions, both rare and unimportant phenomena in dealing with the broader outlines of mammalian distribution. It would be more accurate to substitute "expansion and contraction" for "migration and extinction."[3] However the words be used, it is clear that mammals do not as a rule acquire new territory simply by traveling into it but by a less purposeful peripheral expansion in all possible directions. Similarly, they do not usually lose territory simply by traveling away from it, but by a complex sequence of attenuation and local extinction that can be called contraction. (Fig. 1.)

Regarding the usual relationship of spatial distribution to time, there are two extreme theories, that of "age and area," expounded by Willis (1922), and that of "hologenesis," advanced by Rosa (1931) and supported in its zoogeographic implications by Fraipont and Leclerq (1932). Willis is a botanist and bases his theory mainly on plants but believes it probably also applicable to mammals. His basic postulate is that new forms of life originate in definite, limited regions from which as centers they expand slowly and steadily as time goes on. Then, as a rule with exceptions, at any given point in time, the area occupied by a form of life should be directly proportional to the age of that form of life. The theory involves various interesting corollaries, such as the belief that endemics or isolated forms of life with narrow distribution are usually young forms that originated where they are found and are just starting on their careers of expansion.

Rosa's theory of hologenesis, on the contrary, has the basic postulate that a new form of life appears simultaneously over a great area, over the entire range occupied by an ancestral form or predecessor. There is, then, no such thing as a center of distribution or a cradle of any form of life. The distribution, as a rule with unimportant exceptions, is at the beginning as wide as it will ever be. Migration (in any sense, or expansion), if it occurs at all, is so insignificant that the broad features of distribution are about what they would be if migration never occurred. The area covered by a form of life tends always to decrease, not to increase. Hence as a rule area is inversely, not directly, proportional to age. The corollary regarding isolated forms of narrow distribution is that they are necessarily the relicts of old groups once more widely distributed.

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[3] Although, since usage makes meaning, I am not prepared to grant that "migration" can not mean what nine zoogeographers out of ten use it to mean

To a more or less orthodox zoologist Rosa's theory seems at first sight so fantastic as hardly to warrant serious discussion. This is still more true of some of the nongeographic aspects of the theory of hologenesis not pertinent here. It seems so obvious that most of the essential geographic implications of the theory are incorrect that I shall not devote time to disproving them, but it is necessary to recognize considerable merit in the work of Rosa, especially as supplemented by Fraipont and Leclerq, less on the theoretical side than in the description and emphasis of real sequences of geographic events. From this limited point of view both the age and area theory and that of hologenesis give true but incomplete pictures. One theory reaches an unsatisfactory conclusion, as far as mammals are concerned, and the other departs from an unsatisfactory postulate, but the combination of the less disputable parts of the two gives a satisfactory result.

One of the many moderate opinions intermediate between the extreme views of Willis and of Rosa is that of Matthew (1915, 1939). Matthew's main thesis, now well known, is that groups tend to spread from centers, that the marginal forms are generally conservative and the central forms progressive, and that most of the main, primary centers of such spreading have, for mammals at least, been in the Northern Hemisphere, most southern mammals being relatively primitive types pushed away from the north by peripheral expansion about these centers. This thesis is not under discussion in the present paper, but the general type of geographic history assumed by Matthew to be typical for mammals is that here more explicitly supported. Writing in 1915, before the recent denials of the existence of centers of dispersal, Matthew took these as universally admitted. His work is full of examples of contracting phases in mammalian geographic history, and it was mainly on a consideration of these that he built his theory.

As a concrete example of expansion and contraction, the distribution of the mastodonts is enlightening and was chosen by Fraipont and Leclerq as one item of evidence for hologenesis. Their map shows a Tertiary distribution essentially world-wide except for Australia and a Quaternary distribution including all North America, a spot in Ecuador, one in India, and one in Java. It is not fatal to their theory that their facts are not straight. Mastodonts entered South America only at the end of the Tertiary and were typically Quaternary all over that continent. They died out in the Old World near the beginning of the Quaternary and are typically Tertiary, only, in those continents.

The fatal flaw in the hologenetic presentation of mastodont history is not factual but in the method of generalization. Lumping the Tertiary as if it were a single point in time, they make it appear that mastodonts arose *in situ* everywhere, which is their thesis but which is certainly contrary to fact. In the Oligocene mastodonts are known only from northern Africa. Many great Oligocene faunas from other continents are known, and it is inconceivable that mastodonts or any possible ancestors of mastodonts would be (as they are) entirely unknown in them if these then already had anything comparable to their maximum distribution. Similarly it is as nearly certain as such conclusions can ever be that mastodonts were present in Eurasia (known in the Lower Miocene) earlier and thence spread to North America (not known until Upper Miocene) and that they were in North America long before they reached South America (not known until the end of the Pliocene) and spread from North America to South America. These facts are consistent with the age and area idea of expansion from a center and are radically inconsistent with the hologenetic idea of simultaneous appearance throughout the whole range.

On the other hand, as mastodonts declined it is evident that their area greatly diminished until only one or a few relicts were left in relatively limited regions. This part of the history, if taken alone, is consistent with hologenesis. It is not, in itself, inconsistent with age and area, which admits the reality of such cases as exceptions, but it becomes inconsistent if shown to be usual rather than exceptional, and this can, I think, be shown.

The accompanying map (Fig. 2) epitomizes what is known of mastodont distribution in space and time. I hold no brief for the accuracy of this map in detail: there are great gaps in knowledge, and later discoveries will necessitate changes in the distribution boundaries of the map, which are time contours or isochrones of mastodont expansion and contraction. These isochrones are, however, consistent with what is now known (which the map of Fraipont and Leclerq is not), and I venture to predict that later changes of detail will not much affect the general character of their pattern.

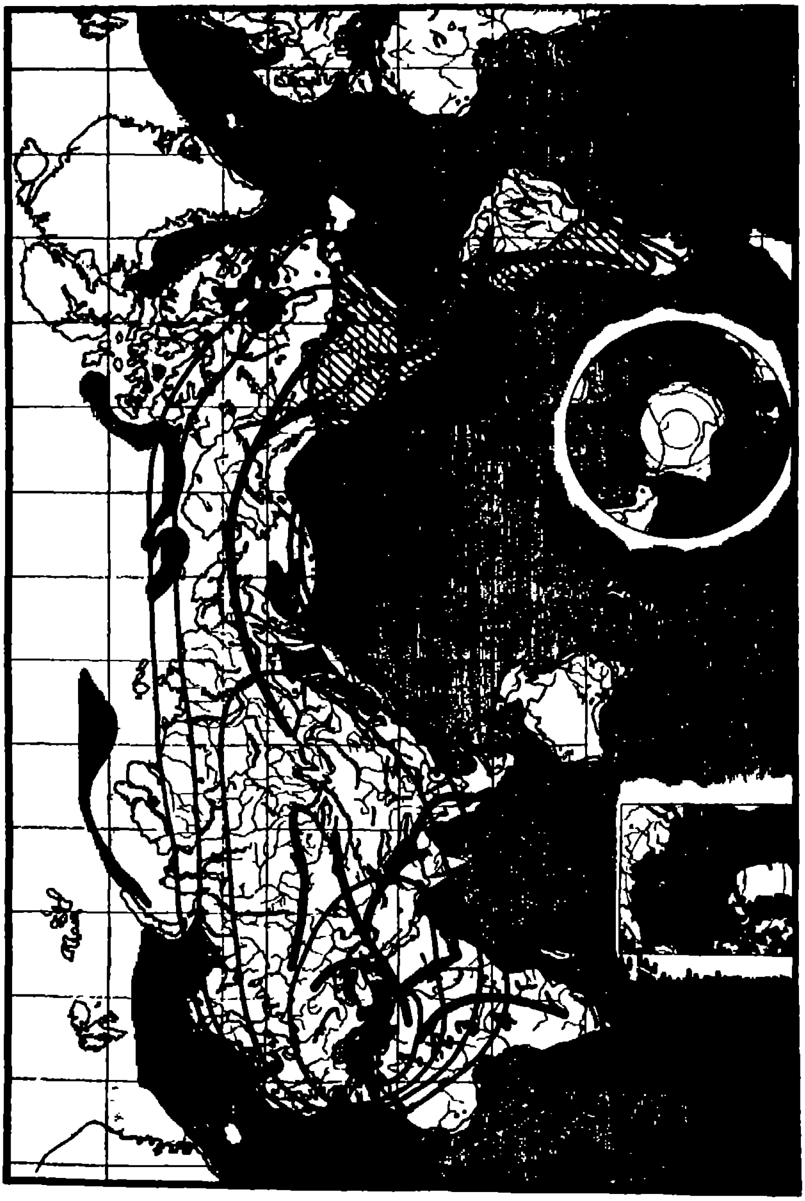

Fig. 2.—Approximate known distribution of mastodonts at various times The numbered lines, 1 to 5, represent stages in the expanding phase, the shaded area a nearly terminal stage of the more rapid contracting phase The heavy lines roughly represent some of the major lines of travel, or so-called migration routes

This I believe to be the type of pattern that would be shown by almost any form of life[3] that had run its entire course from origin to extinction. A form appears in some center or "cradle," not an exact spot that could be marked with a monument but, say, a single biotic district or province. Thence it tends to spread steadily in all directions until it encounters insuperable barriers. After a time it begins to contract, possibly but not usually toward its center of origin and often splitting into disjunctive spots as it contracts. Finally it disappears. (Fig. 3.)

The expansion of a group of animals involves actual motion. Individual animals must move from place to place, and some of them must travel where their immediate ancestors had never been. The population as a whole must move outward along its periphery. Contraction does not, or need not, involve any motion. It does not necessarily mean and in reality very seldom means a contraction of the population in the sense that there is predominant inward motion along the periphery. It involves rather a process of disappearance or extinction, commonly preceded by a general lowering or attenuation of the population. A population may decrease greatly and actually be well along in its contraction phase before it loses any significant amount of its range by local complete extinction. This phase of contraction can not be simply represented by contours as in the accompanying diagrams, and this essential difference between expansion and contraction must be understood if the diagrammatic representation is not to be misleading.

An excellent descriptive analogy is provided by the expansion and contraction of ice caps. In their expanding phase there is actual movement outward from a center. They may begin to contract even while the movement is still outward, but their definitive contraction is accompanied by stagnation, with thinning of the ice (attenuation of the animal population) before any considerable regression is obvious. Commonly parts of the ice mass will be isolated and remain *in situ* until they melt entirely, just as relicts of once widespread animal groups may be isolated in one or in several separate regions before they become extinct.

It is tempting to go into many of the details and corollaries of this history, but I must limit myself to mention of only one or two. As regards age and area, it is evident that this pattern is partly in agreement with that theory, but the theory is unbalanced in tending to stress the expansive phase as usual or normal and to consider the diminishing phase, which seems really to be an inevitable, integral part of the whole process, as unusual or abnormal. Whether a majority of animals at any given time were really distributed in accordance with age and area would depend on whether more were then in the expanding or in the contracting phase and on the relative speed of these phases. It seems probable that at the present time, including the recent past, more mammals are actually in the contracting phase, so that age and the area is a poor guide to the recent distribution of this particular group of animals.

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[3] The expression "form of life" is intentionally vague for the purpose of generalization. Of course, it is not supposed that a single race or species goes through the whole course of such a cycle unchanged. General racial evolution, modification in local environments, and many other factors greatly complicate the issue. It would be impossible in limited space to attempt consideration of such modifications and it would merely confuse the broader trends that are believed to be real despite these complications.

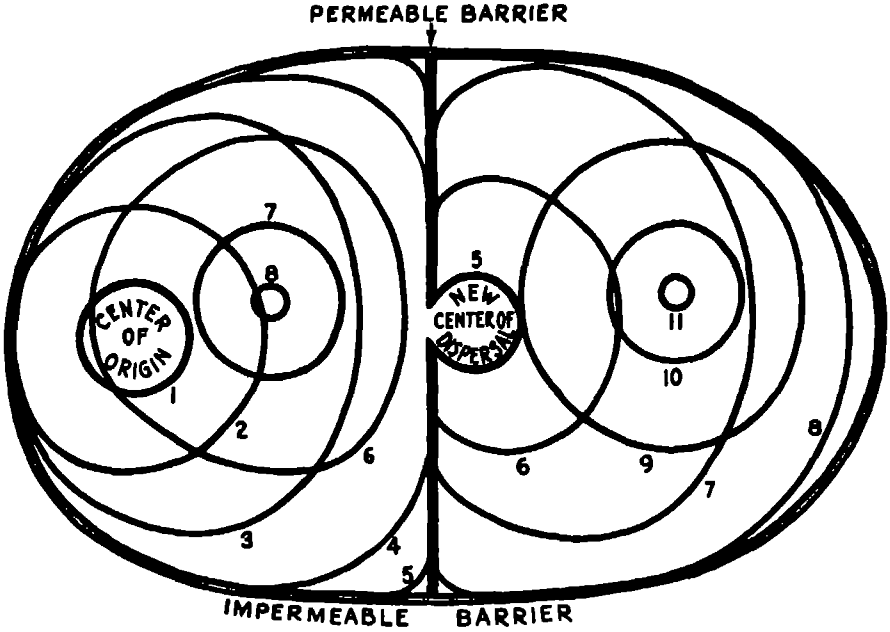

Fig 3—Diagram of a common type of mammalian expansion and contraction, exemplified in varying detail by the mastodonts and other groups The numbered lines 1 to 11, represent limits of distribution at various times 1 to 5 represent the primary expansion of the group on the land-mass where it originated, 5 to 8 contracting phases here. At time 5 it crosses a barrier and from 5 to 8 expands on a second land-mass, contracting there from 8 to 11 From 6 to 8 the group has discontinuous (disjunctive) distribution in two areas After 8, it is extinct in its home-land but survives abroad After 11, it is everywhere extinct

One other striking detail is that we can as yet seldom follow the actual expansion of a group of mammals within its set of barriers. Sometimes related mammals do really seem to appear all at once over the whole of a great area inhabitable by them, and subsequent expansion, if it occurs, is not such in the simple age and area sense but is by flooding through a broken barrier: this is in part true of the spread of mastodonts into North America in the Miocene.[4] It is these cases of sudden widespread appearance that are used to support hologenesis, but the support is spurious.[5] One reason for the apparent widespread simultaneous appearance is the imperfection of the record and of our interpretation of it. For any one age we are lucky to get one good fossil deposit on a continent and almost never have deposits so placed all over a land mass that the expansion could be recorded. And even if we did have such ideal data, our usual methods of correlation would very seldom permit so precise a following of the real sequence. We usually establish a theoretical sequence by assuming (doubtless contrary to fact but as a workable approximation) that given types of mammals did appear simultaneously over the whole area—obviously it is then ridiculous to expect this sequence to show that they did not. Only when different faunas cross barriers and impinge on one another is it easy to show that expansion has occurred. The other reason is that the expansive phase of mammals is normally very rapid unless definite obstacles slow it down. Once a group of mammals gains access to a land mass, it tends to spread over it in the wink of an eye, geologically speaking. A century or a millennium may suffice, and in most cases such periods are imperceptibly short to the paleontologist.[6] Only in dealing with recent mammals is one likely really to see expansion taking place on a smaller scale.

Mammalian distribution as the paleontologist sees it is thus seldom concerned with the spread of any group on a single land mass. Relatively local differences are usually to be assigned to environmental or facial causes, while differences between larger areas are usually to be interpreted not primarily from the age and area viewpoint of simple time elapsed but more from the point of view of the rise, fall, and character of intervening barriers. The paleontologist's cardinal principles (open to exception) are (*a*) that strong differences between approximately contemporaneous mammalian faunas of similar facies imply an intervening barrier and (*b*) that strong resemblances between such faunas denote an intervening connection.

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[4] But I do not doubt that they would have passed the barrier earlier if they had reached it earlier, so that this is only a modification, not a contradiction, of the age and area type of expansion

[5] To mention only one of several cogent reasons, because adequate data always show that new forms appear first only on one side and never on both sides of a barrier.

[6] Willis foresaw that the great mobility of mammals might vitiate the application to them of his age and area theory, which as a matter of practical observation demands that spread should be very slow, as it commonly is among plants and some animals but rarely among mammals His thought that the theory might, after all, apply to mammals was based largely on the fact that some of them gave a "hollow curve" for number of genera plotted against number of species, but such a curve seems to me inevitable either in the expanding "age and area" phase or in the contracting phase. Perhaps in an intermediate relatively stable maximum phase it would not occur, but even this is doubtful.

Thus the paleontologist would seldom conclude that a given sort of mammal occurred on one continent but not on another simply because it had not had time to reach the second, but because there was no likely way for it to get there. If, then, this sort of animal did later appear on the second continent, he would normally conclude that something had happened to provide the means of getting there, and not that the animal only then got around to using the means that existed all along. These interpretive principles are widely accepted, so much so that real exceptions to them have greatly confused zoogeographers.[7] Generally true, they are the basis on which the paleontologist and zoogeographer collaborate with the geologist in establishing the probable presence or absence of land connections between the continents in past times.

TYPES AND EFFECTS OF MIGRATION ROUTES

Corridors

If no barrier at all exists between two areas, it is to be expected that their faunas will be very similar, or as far as genera or larger groups are concerned practically identical. Such radical differences as exist will be mainly or wholly caused by the survival or development of local forms in some narrow environment, that is, will be facial and not geographic in a broader sense.

As an example, a comparison of the living mammals of Florida and New Mexico (Simpson, 1936) shows the degree of similarity attained by areas in which there is no significant geographic barrier but where the local climates and facies are almost completely different in the two areas. For various reasons not pertinent here, the mammalian fauna of Florida is relatively small, with only a quarter as many species as in New Mexico, but of the orders of mammals present in Florida, all occur in New Mexico, of the families over nine-tenths, of the genera two-thirds, and of the species nearly one-fifth. If these were fossil faunas resemblance this great (or, as is often the case, greater) would warrant the conclusion that no barrier did exist between the two. This criterion can be applied in close parallel. It was formerly sometimes supposed that when Florida first definitively appeared as dry land in the mid-Tertiary it was not yet connected with North America. Now we have from there Middle Miocene mammalian faunas with ten genera surely and six others doubtfully identified. Of these, all but one are common in contemporaneous beds in western North America. The conclusion that there was no sea or other notable barrier between Florida and these States is inescapable. Such evidence suggests not merely that a bridge existed but that none was needed; that the two areas were part of a single land mass.

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[7] Cases of spread over "sweepstakes routes," discussed on a later page, are the most confusing of these real exceptions

Filter-Bridges

When two regions are separated by a strong barrier, they develop quite different faunas, the differences being roughly proportional to the lapse of time since the regions were connected. If now some means of passing the barrier appears, the two faunas intermingle, but usually the result is not the production of a single fauna even in the sense that Florida and New Mexico have one fauna. Several factors are concerned in the usual fact that such regions tend indefinitely after they are united still to have distinctive faunas, despite their sharing of some faunal elements. From this point of view the fact that the regions often are different environmentally exerts a profound effect, but one not of primary importance in the phenomena here considered because the effect might have been analogous even if the regions had always been united. A more important factor is that biological pressure of immigrant forms may inhibit the expansion of some groups in one region without being sufficient to cause rapid extinction, although in such cases extinction usually follows sooner or later. Equilibrium does occur but is seldom or never permanent.

Another and for the present subject a more important reason for the continued distinction of two faunas between which a barrier-crossing has been established is the character (including the position) of that crossing. Its approaches may be inaccessible for some animals, and of course they can not use a bridge that they can not reach. From the animals that do expand into a new land mass, it is sometimes possible to infer where the bridge was. Thus when North America and Asia had a great faunal interchange in the Pleistocene, no mammals then confined to southern North America reached Asia and none then confined to southern Asia reached North America. Obviously the bridge was in the north and exclusively southern animals could not reach it. It is also noteworthy that none of the mammals that had come into North America from South America reached Asia. To reach North America they had to come through the Tropics, and none was sufficiently adaptive also to pass over a relatively cold bridge.

Here the character of the mammals themselves is a determining factor. What is a barrier for one is not for another, and conversely what is an open route for one is not for another. The Asia–North America bridge opened the barrier for elephants (mammoths) but not for gazelles. The North America–South America bridge opened the barrier for horses but not for bison. This strongly selective action depending on the position and character of the bridge and the consequent environmental conditions of it and of its approaches is a rule with few exceptions. Another way of putting this would be to say that the true barrier in such cases was not the presence of a stretch of sea but some less obvious environmental factor, such as climate or vegetation, and that for these animals the apparent bridging of a barrier had no meaning because the true barrier remained untouched. (Fig. 4.)

In the inference of intercontinental land connections from faunal relationships it is, therefore, wrong to demand that anything like a complete faunal interchange be adduced as evidence of the existence of the connection. A wide-open, nonselective connection, a corridor, is the only sort that could approach such a result, and these are rare.[8] In the whole history of mammals there are exceedingly few cases (e.g., Lower Eocene between Europe and North America) where the evidence really warrants the inference of a wide-open corridor between two now distinct continental masses. The usual sort of connection is selective, not acting as a corridor or open door but as a sort of filter, permitting some things to pass but holding back others. From the probable mechanism of such filtering of faunas, it follows that these connections were usually of narrow environmental scope and their continental abutments limited, drawing only on one faunal zone of the continent, not on its fauna as a whole. In other words, the usual evidence for such connections does not suggest "lost continents" comprising parts of two or more as they exist today, or even broad transoceanic pathways, but relatively restricted links. The analogy of a bridge for such selective or filtering connections is fairly good, and it is to them that the term "land bridge" most properly applies.

From the point of view of paleogeography, the sort of bridge that

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[8] Europe and Asia are now connected by a corridor, but zoogeographically they are not distinct continents One of the many arguments against the Wegener hypothesis, at least in any application to mammals, is that the connections that it provides are corridors, but the faunal relationships on which it depends for evidence would not be produced by corridors

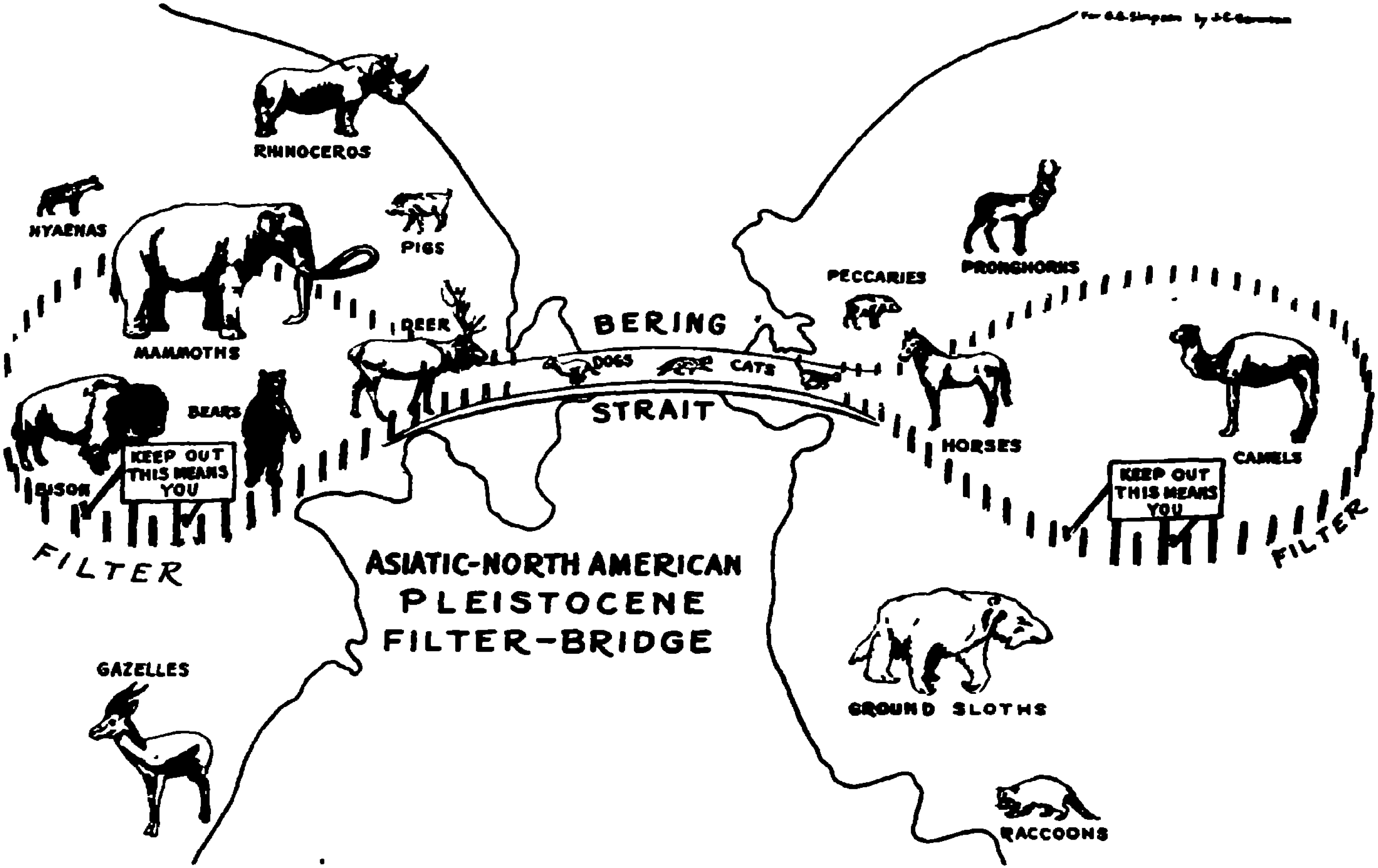

Fig. 4.—Diagrammatic conception of Asia–North America Pleistocene filter-bridge.

best fits the zoological evidence in such cases of extensive but filtered faunal interchange is an isthmian link in the sense of Bailey Willis (1932). The broad land bridges of many paleogeographers should be corridors from a faunal point of view, but isthmian links, more nearly than any other geologically postulated connections, fill the requirements of a filter-bridge, which the faunal evidence shows to be the usual type of intercontinental connection although, of course, by no means the only type.

When it is recognized that a filter-bridge does not lead to an integral transfer of continental faunas, it is a practical problem to determine what sort and degree of resemblance does indicate such a bridge. There have been students who did not hesitate to build extensive individual bridges in all directions to account for peculiarities of distribution in single forms of life. Thus, to mention only a few of his many connections,[9] Joleaud (1924 and elsewhere) has an individual Late Oligocene route from Haiti to west-central Africa for insectivores, one diagonally across this from Brazil to northwestern Africa in the Late Eocene for certain rodents, one in the Early Miocene straight across the Atlantic from the United States to Spain for a genus of horses, *Anchitherium*, one at the same time parallel to but south of this from northern Africa to Florida for the mastodonts, and so on. Similarly, von Ihering built a special bridge across the Pacific from South America to Asia for raccoons and bears,[10] and examples could be multiplied. Aside from geological considerations, which in themselves are almost enough to exclude these particular bridges at these places and times, and aside from what are now known to be errors in the factual data adduced for them, such individual, self-service bridges are supposed to have acted in a way in which no surely established bridge is known to have acted, and I can not believe in their reality.

One good criterion of the reality of a bridge is that it should have acted in both directions. Provided that both areas had land faunas, there seems to be no proved case in which a bridge has conducted animals only from one to the other and not in both directions. This is true even when one fauna was decidedly dominant and tended as a general rule to suppress the other or to inhibit its expansion. For instance, the South American ground sloths were doomed to extinction when they came in contact with the North American fauna, but first they penetrated far into North America. The armadillos, also archaic animals such as might be expected to contract in distribution, have gained an even more enduring foothold in North America and are now (for at least the second time) expanding there. One of the best arguments against the disputed derivation of South American marsupials by land bridge from Australia (direct or via Antarctica) is that the evidence favors migration only from Australia to South America, with none in the reverse direction even though the South American mammals must have been at least as capable of expansion as the Australian.[11] This and other evidence regarding this particular hypothetical migration route have been discussed elsewhere (Simpson, 1940). (Fig. 5.)

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[9] Postulated not necessarily as bridges but possibly as connections of similar effect but a different sort by an "accordion" motion of the continents on Wegenerian lines

[10] Such a rapid summary is hardly fair either to Joleaud or to von Ihering, who adduced considerable evidence for their views (although some of the evidence has since been shown to be erroneous), but it is necessary to mention one or two instances as briefly as possible in order to demonstrate that I have not set up a straw man Citation of the vagaries of less distinguished men would not warrant mentioning the point in so general a review.

The second and perhaps the best criterion of the reality of a land bridge is that even though it rarely transports whole faunas, it does tend to transport integrated faunules. It does not transport all the genera of a continent, but neither does it transport one genus all by itself. For instance, it is improbable that only herbivores or only carnivores would cross such a bridge (although they need not both cross in the same direction). Where herbivores go, carnivores can and will accompany them, and carnivores can not go where there are no herbivores. The postulation of land bridges on the basis of one or a few mammals is thus very uncertain. Unless there is reasonable possibility that their companions have not been discovered, a theoretical bridge based on such evidence is probably unreal.

Sweepstakes Routes

There are, however, instances of migrations of single groups of mammals or of unbalanced faunas that did occur but that do not meet these criteria for filter-bridge connections and, of course, still less those for corridors. Many insular faunas are of this type, as a whole. Madagascar and the West Indies are classic examples. As carnivores, Madagascar has only peculiar viverrids, relatives of the civets, although nearby Africa is abundantly provided with cats

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[11] It is conceivable that a bridge might function in one direction by a sort of lock or storm-door action, an otherwise uninhabited region receiving a fauna first from one source, losing that connection, and only then being united with a second continent, so that animals would be transported from the first to the second but not in the other direction There is, however, no good evidence that such a peculiar sequence of events ever actually happened and it should hardly be postulated except in the absence of any acceptable alternative hypothesis

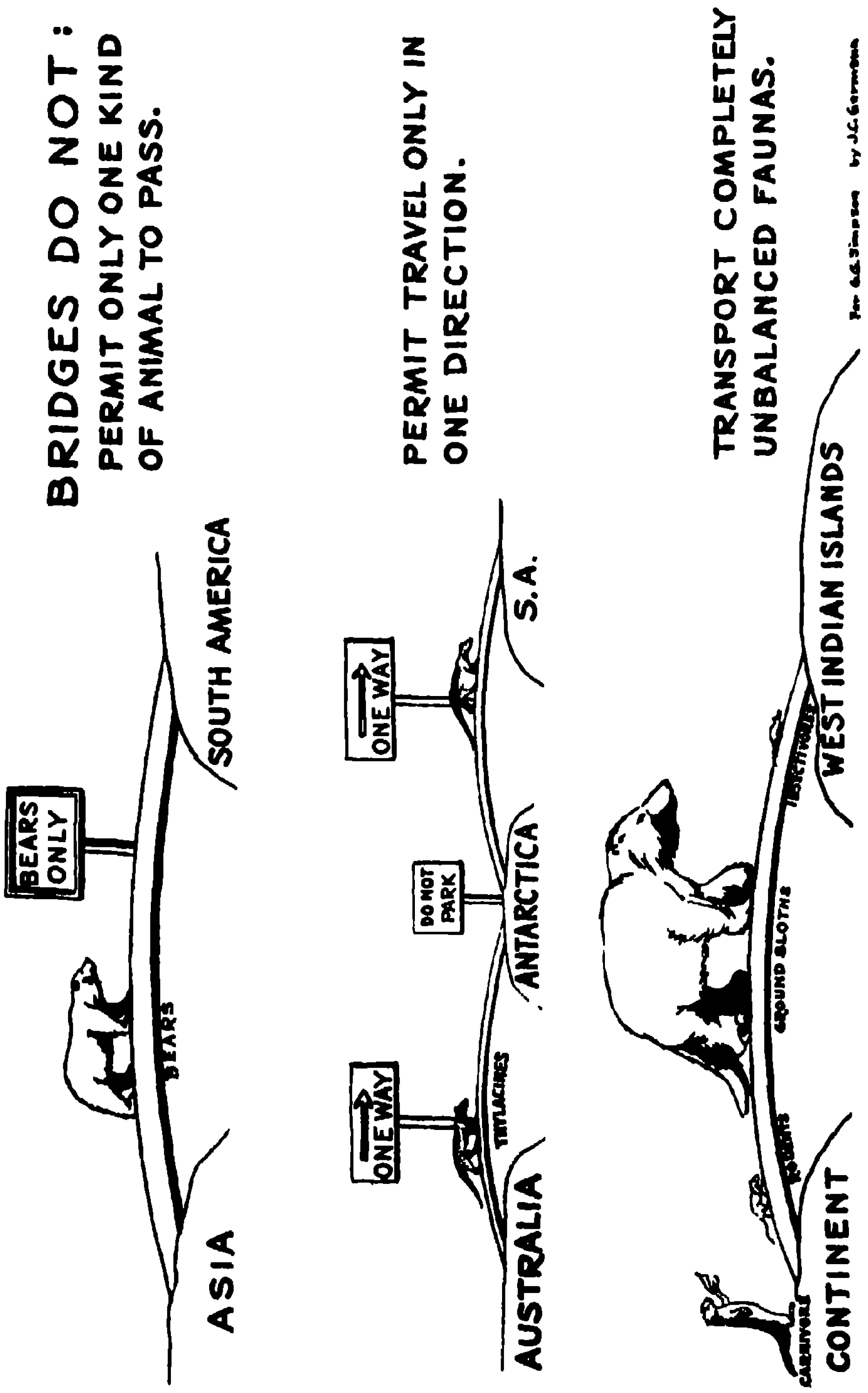

Fig. 5.—Diagrammatic conception of filter-bridge incompetence.

large and small and various other carnivores. Madagascar's insectivores and rodents are also peculiar and each group is related to only one of many African types. Madagascar has many primitive primates and lemurs, but no apes or monkeys. These are all ancient forms and constitute a very unbalanced fauna that must have entered (whether together or separately) by the middle Tertiary at latest. The only ungulates are a pigmy hippopotamus (now extinct) and a bush-pig, both of which must have reached Madagascar much later than its other mammals and which are, again, an example of migration that can not possibly be explained by an ordinary filter-bridge. In the West Indies the Pleistocene land mammals included only peculiar rodents, insectivores, and ground sloths, without any of the ungulates, carnivores, and other groups abundant on all adjacent continental areas. This fauna, too, is inexplicable as a result of normal filtering on a land bridge such as is here envisioned. I am aware that some excellent authorities do maintain that these faunas arrived over bridges (see general summary in Schuchert, 1935), but I can not feel that they have clearly seen or considered the conditions that could give such a result. (Fig. 6.)

There are also instances of the appearance of isolated immigrants on continental masses. A curious and relatively neglected example, among many that might be cited, is that of the sudden appearance in South America of small relatives of the North American raccoon. These procyonids appear as fossils in the Late Miocene or Early Pliocene of Argentina definitely before any of the other carnivores or any of the abundant North American ungulates reached there. Since in this case a filter-bridge certainly existed at a later time, it is usual to assume that the procyonids came on this bridge and that their appearance dates the formation of the bridge as a practicable migration route or true and complete filter-bridge. If, however, we consider only the time when the procyonids did appear, disregarding our knowledge of what was destined to happen later, such a conclusion is not warranted. If my previous remarks as to filter-bridges are true, or are acceptable as a theory of general tendencies, then it is wrong to conclude that a bridge can account for the appearance of this one group of small carnivores and no other animals of similar geographic origin at that time, unless the bridge was then so nearly impassable as not to warrant the name in its usual accepted sense.

The late W. D. Matthew, who was probably the most distinguished and best informed student of problems like this, concluded that insular and highly unbalanced faunas were probably to be accounted for

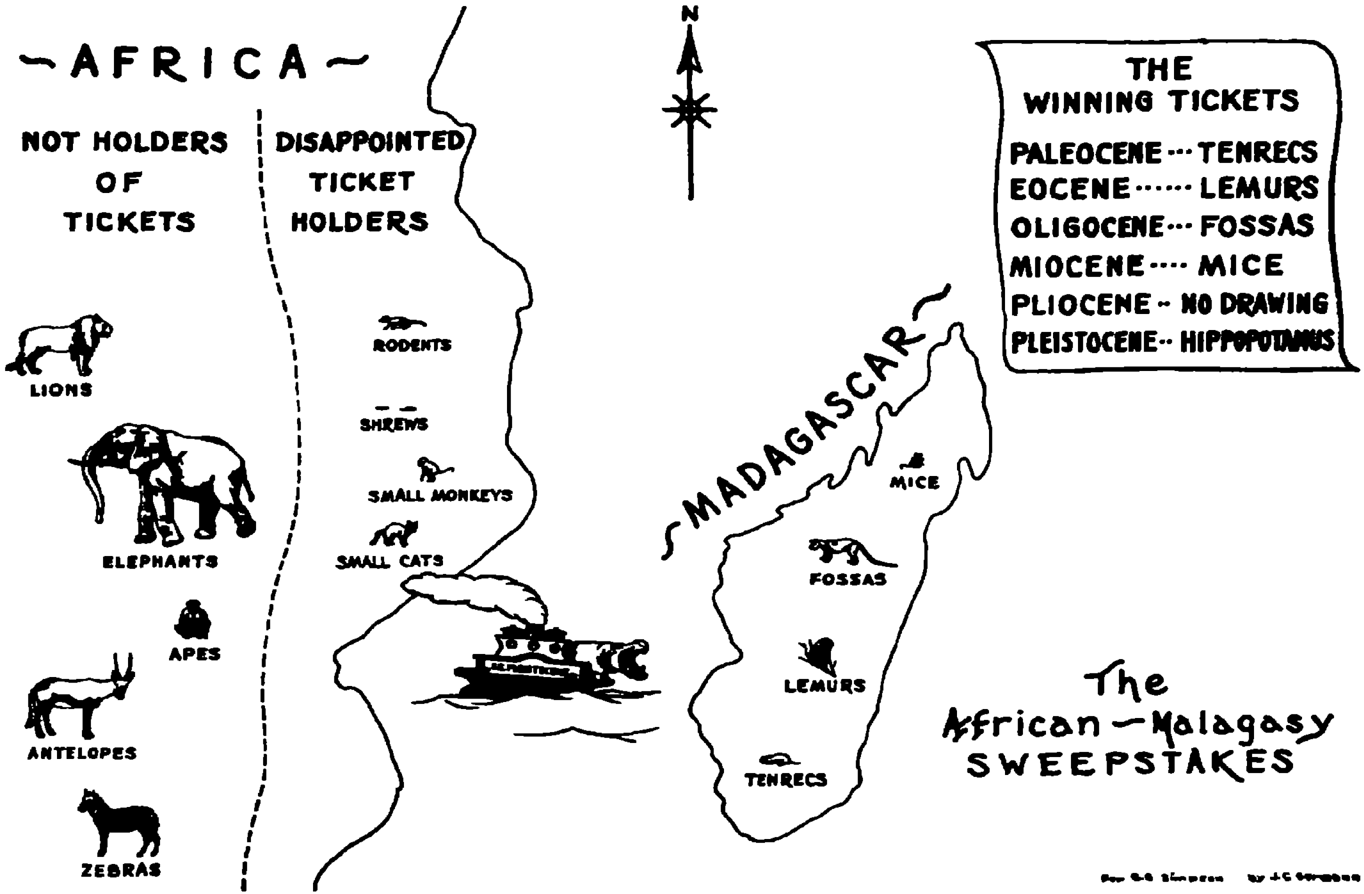

Fig 6.—Diagrammatic conception of the "sweepstakes" route between Africa and Madagascar.

by sporadic transportation of land animals on natural rafts, without the existence of a dry-land route (Matthew, 1918, 1939). This opinion has been severely criticized in some quarters. It has been claimed or felt, even by some adherents of Matthew's general thesis of "Climate and Evolution," that this sort of adventitious migration is dragged in when necessary to explain away any facts that contradict the main thesis.

It has not been sufficiently emphasized even by Matthew that the role of such a theory may be positive and primary, not merely negative and supplementary. Adventitious migration has indeed been used and sometimes abused simply to get inconvenient facts out of the way of a favored hypothesis, but there are instances in which adventitious migration is itself the most probable hypothesis and the most economical theory. In the cases of the faunas of Madagascar and the West Indies, for instance, I strongly favor this explanation, and I do so not at all in order to explain away data for a land bridge where I do not want to believe in one—as Matthew has, quite incorrectly, been accused of doing. It is to be favored because it does explain, simply and completely, facts that the land-bridge theory does not explain.

This sort of migration can be extended to include cases other than those of transportation by natural rafts, although doubtless these provide the most common instances. Any barrier, whether of water, climate, biota, or other, may or will be involved in such migration if its crossing at any one time is highly improbable but is not impossible. The action is not merely like that of a relatively less permeable filter but is different in kind as well as in intensity. A filter-bridge permits some animals to pass and holds others back, but in general those that can cross it do cross it and do so fairly soon after the bridge becomes available to them. It is relatively deterministic as to the fact of crossing, as to the animals that do or do not cross, and as to the time of crossing. An adventitious route, which I call "a sweepstakes route" to emphasize this characteristic, is indeterministic. Its use depends purely on chance and is therefore unpredictable and, except in a broad way, can not be clearly correlated with other events in time and space, as filter-migration can.

If a sweepstakes route exists, it depends on chance whether a given type of animal that can cross it will really do so, which of two types of animals will cross first, and when any particular types will cross it. It is, for instance, my belief that such a sweepstakes route for land mammals now exists between Asia and Australia, that it has existed since toward the end of the Mesozoic, and that no more tangible route, such as a filter-bridge, has existed there during that time. Certain Asiatic mammals can not follow such a route, and in this sense it, too, has a filtering action. It is not really a route for such mammals: they do not hold tickets in the sweepstakes. Other mammals, particularly small arboreal types, can. All these have tickets in the sweepstakes, some types holding more tickets than others and so having more chances, and any of them might win at any time, but any one is unlikely to do so at any one time and the less likely can win before the more likely do. A given sort of mammal might have crossed at once, might have crossed at any time from Cretaceous to Recent, or might never have crossed. Whether it crossed and when it crossed were matters of chance, in a sense almost exactly analogous to the chance of throwing a given point with dice. (Fig. 6.)

This is, I think, the only theory yet advanced that really is capable of explaining all the peculiarities of the Australian fauna and many similar but less extreme peculiarities of land faunas in other parts of the world. That such theories have not received much attention and that they are uncongenial to many zoogeographers are perhaps a reflection of the mechanistic scientific philosophy dominant in the Victorian age, from which zoogeography has not fully emerged. Land-bridge migration seems more mechanistic because it is often more simply predictable. In fact, of course, it too depends on chance, but here on the chances of a probable event, whereas sweepstakes migration depends on the chances of an improbable event.[12] The viewpoint involved is, I believe, new, and it merits detailed consideration, but this can not be given it here. Among other points, the physical nature of such sweepstakes routes needs study. It is not to be supposed that they are invariably island stepping-stones or that natural rafts are the sole means of transport involved.

A FILTER-BRIDGE IN ACTION

As an example of what actually happens when two continents are united by a filter-bridge, the case of North and South America is one of the most interesting and the facts about it are now fairly well known. These continents were separated (except, probably, for a sweepstakes route) almost throughout the Tertiary. Toward the end of the Pliocene they were united by an isthmian link antecedent and similar to that now existing, the Isthmus of Panama. For the mammalian faunas this was and is a filter-bridge.

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[12] Students of statistics will recognize a relationship with the binomial of probability approaching forms like the normal distribution when chances are about equal and approaching forms like the very different Poisson distribution when chances are very unequal.

Just before the two continents were united, South America had about 29 families of land mammals and North America about 27.[13] With two doubtful exceptions,[14] they did not then have any families in common. Shortly after the union of the continents, in the Pleistocene, they had 22 families in common, 7 of South American origin, 14 North American, and 1 doubtful. Some extinction already having taken place, South America then had 17 native families still confined to it and North America 9.[15] With further extinction and some further migration, the Recent faunas of these continents have 14 families of land mammals in common and there are 15 families confined to South America (not all native) and 9 confined to North America. There was thus a great faunal interchange but one that never produced even approximately identical faunas, involving many mammals from each continent but never all or even the majority—a typical picture of the action of a filter-bridge on the continental faunas at each end of it.

In passing, there are various interesting facts involved in these summary figures. The South American fauna is now about as rich as it was before the interchange, but very different. North America has a decidedly poorer fauna than before the interchange, but its general composition has not changed so much as in South America. Both faunas reached their maximum in variety soon after the interchange and later declined.

The broad outlines of what actually happened can be seen by summary of the histories of the various major groups of mammals involved.

Certain groups expanded into the other continent and became permanently at home there, without losing much of their former range, the "age and area" type of expansion. The groups of which this is true were almost entirely of North American origin and include some rodents, especially the cricetids, most of the carnivores, and, among ungulates, the deer. Among South American mammals only the porcupine can unquestionably be placed in this category although there are one or two other less clear or more complex cases, e.g. the peba armadillo.

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[13] The exact figures depend on the classification used and are not important except as they express relative values.

[14] Didelphidae and Procyonidae, possible exceptions for different reasons not affecting the basic situation here described.

[15] Some of these, on each side, did manage to spread slightly beyond the isthmus, but not to colonize the other continent widely.

Some groups seem to have been almost unaffected. It must be supposed of these that they had not reached a contracting phase in their history, that a barrier continued to exist for them (the filter-bridge filtered them out of the flow of mammals), and that the contact of new types of mammals was not lethal. This is true of a few more South American than North American mammals, but the difference is not significant. In North America the moles, pocket gophers, beavers, kangaroo-rats, prongbucks, bison, and a few others belong here. In South America the (tree) sloths, anteaters, most of the armadillos, the monkeys, and most of the native rodents (eight families out of twelve, and lesser groups in the other families) may be mentioned. Some of these managed to get onto the bridge (for instance several sorts of monkeys), but none really succeeded in crossing it.

I do not know of any single unified theory that would account well for the fact that these animals did not cross the bridge and yet did not markedly contract. The age and area theory demands that they (or most of them) be new groups that have not yet had time for this expansion, but this is clearly false. Most of these are ancient types of animals in their own continent. All certainly have had ample time to cross the bridge if they were going to do so. They are not inconsistent with Matthew's "Climate and Evolution" theory, but neither does it explain them; these data are outside that field of theory. The reasons are probably too varied to be reduced to a formula more specific than that of general filter action. For many of these animals, such as the monkeys, the absence of necessary environmental conditions beyond the bridge is an evident reason for their stopping where they did. Others, like the bison, were evidently kept by analogous environmental barriers from reaching the bridge. In some cases, for instance many of the rodents, it is hard to believe that the physical, climatic, or floral environment can have sufficed to prevent their spread and the most reasonable inference seems to be that these animals were able to maintain their places in the shifting fauna around them, in the region where they were well acclimated, but not quite able to invade the same ecologic niches where these were already occupied under somewhat different conditions, even though these conditions would not have been deterrent if there were no competition. The explanation is vague and not very satisfactory because it seems unlikely that so delicate an equilibrium could long be maintained.

Some groups began to contract at or soon after the time of faunal interchange. Doubtless some would have contracted anyway, but it can not be coincidence that so many did so just at this time. In North America there were few examples of this. Some North American groups have contracted since the connection with South America, but in these cases there is little doubt that the contraction had quite different causes and would have occurred regardless of the rise of the land bridge in question. In South America, however, the sharp contraction and eventual extinction of all the native carnivores (the borhyaenid marsupials) and all the native ungulates (notoungulates and litopterns) undoubtedly were related to this event and so, probably, was the contraction, with or without extinction as yet, of various native rodents and of the caenolestid marsupials.

It is highly improbable that none of these animals could have crossed the bridge successfully as far as most environmental factors go. Some of the notoungulates and borhyaenids, for instance, were ecologically similar to animals that did cross the bridge and they lived in environments abundantly available in North America. The only probable explanation is that these animals were biologically inferior to immigrants from North America. The impact of the latter not only prevented the expansion of these South American groups but also started or hastened their contraction. The contraction was slow in some cases, occupying a million years or more, but it effectively prevented acquisition of new territory and in most cases has now ended in extinction. In this instance, and probably this is the rule for mammals, expansion of groups that did expand was plainly more rapid than the contraction of those that did contract.

A final category is provided by the various sorts of mammals that expanded when the continents were united but that later contracted again. This was true of about as many North American as South American mammals. It is a phenomenon still more complex than those already mentioned and the land mammals so affected may be placed in three categories:

1. Those that expanded into the other continent and then became extinct in both:
   (a) Of South American origin: Glyptodonts, ground sloths (several families)
   (b) Of North American origin: Gomphotheres (bunodont mastodonts),[16] horses.
2. Those that expanded into the other continent and then contracted (or in one case became extinct) there but were not much restricted in their original home:

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[16] These were not ultimately of North American origin, but those involved in this interchange were. Throughout this discussion North American origin means simply not South American, only these two continents being considered.

(a) Of South American origin: Capybaras, armadillos.
(b) Of North American origin· None

3. Those that expanded into and survived in the other continent and became restricted or extinct in their continent of origin:
(a) Of South American origin: None
(b) Of North American origin: Tapirs, camels, peccaries, short-faced bears.[17]

The first of these three categories can be dismissed (although hardly explained) as including groups that would have become extinct in any case but that happened to share in this last expansive movement before fatal restrictions set in. The last two are complementary and show an interesting relationship. No North American groups became extinct in South America and not in North America. If they became extinct in South America they were, so to speak, slated for extinction anyway and the new environment did not save them. On the other hand several North American groups became extinct at home but not in South America.[18] These were, then, contracting groups, for which extinction was postponed by the change of environment. South America was an asylum for them in their retreating phase and the preceding expansion was rather an incident than an indication of potency against their old environment. Here again both the age and area and the hologenetic theories are far beside the point when confronted by the actual facts. On the other hand, this particular class of facts is broadly consistent with Matthew's views, especially when details here omitted are considered.

South American groups that were contracting, or were destined soon to contract, in that continent either were unable to reach or, in rarer cases, did reach but could not survive in the northern continent. Even some animals that remained potent and at least did not markedly contract in South America were unable to maintain themselves in North America after reaching there. Generally speaking, the faunal interchange was far from equal. In the long run the two faunas did not mingle as much as one invaded the other. The North American mammals were on the whole definitely more potent and more expansive than the South American, both in their ability to migrate and in their ability to survive, a generalization supported by the following tabulations, in which the figures are numbers of families of land mammals known to have existed in the two continents at about the time when the bridge arose. (Doubtful cases are omitted.)

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[17] These have also contracted considerably in South America.

[18] I include peccaries in this group because they contracted greatly in North America (also, but to far less extent, in South America) and in all probability would have become extinct in the north if no asylum had been offered them, and may indeed still become extinct first in the north.

TABLE 1.—ASSOCIATION OF MIGRATION AND SURVIVAL WITH GEOGRAPHIC ORIGIN

	Of South American origin	Of North American origin	Ratio of ratios, favoring North America
Migrated to other continent	7	14	
Did not migrate to other continent.	21	11	
Ratio	.33	1.27	3.8
Now surviving	17	21	
Now extinct	11	4	
Ratio.	1.55	5.25	3.4

These differences are statistically significant, the first surely, the second probably.

A priori it would be expected that the ability to accomplish such a migration, an indication of expansive power at the time, would be related to ability to survive. It is possible that there is a relationship here, but if so it is more complex and involves other factors. Simple tabulation of the same families shows no such tendency:

TABLE 2.—ASSOCIATION OF MIGRATION WITH SURVIVAL

	Migrated to other continent	Did not migrate to other continent
Now surviving	15	23
Now extinct	6	9
Ratio .	2.50	2.56

The difference is far from significant. As far as these figures show, a family capable of spreading to the other continent was no more likely to survive than one that did not spread.[19] Thus in the final outcome of the interchange, as far as yet reached, the ability of these faunas to expand and their ability to survive are both associated with geographic origin, or biologically with the general character of the historically northern, Holarctic, as opposed to the historically southern, Neotropical, fauna. But ability to expand and ability to survive are two different faunal characteristics in this instance with no apparent relationship to each other.

Like so many phases of this great subject on which I have barely been able to touch in passing, this unexpected conclusion has far-reaching implications and merits much more detailed consideration than can now be given it. An enormous amount of work has been done to unearth the facts of faunal distribution in the past and present.

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[19] Use of smaller taxonomic units, such as genera, gives larger figures but obscures the conclusion sought. Commonly the act of spreading from one continent to the other was accompanied by evolution of generic rank. The use of actual phyla would be ideal but is impractical because these are not sufficiently well known in many cases.

Far less progress has yet been made in finding the broad interpretive principles that may be revealed by these facts. Here an effort has been made to indicate what a few of these principles may prove to be and, more particularly, to suggest a few of the lines of attack that may lead to clearer grasp of these and to the discovery of others.

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PALEOBOTANY.—*The Pliocene Esmeralda flora of west-central Nevada.*[1] DANIEL I. AXELROD. (Communicated by ROLAND W. BROWN.)

One of the results of recent collections of later Tertiary floras over the Great Basin province has been the discovery that the Esmeralda flora described by Knowlton (1900) from the northern end of the Silver Peak Range, Esmeralda County, Nev., is distinct from the Coal Valley flora reported by Berry (1927), which lies in the drainage of the East Walker River 75 miles northwest. A well-preserved flora of approximately 50 plants has been collected at Coal Valley and will form the basis of a subsequent paper. The present brief report adds six species to the Esmeralda flora and includes an analysis of previously collected material now at the United States National Museum. Acknowledgement is made to Dr. Roland W. Brown for assistance in examining the collections, to the Carnegie Institution of Washington under whose auspices the collections were made, and

[1] Received November 20 1939.

to the National Research Council for the grant of a fellowship to study the later Tertiary floras of the Great Basin province.

The Esmeralda formation is in large part a fresh-water deposit, made up of shales and coal seams in the lowest part, with sandstones, conglomerates, and volcanics occurring higher in the section. Although a vertebrate fauna has been collected from these beds (Stirton, 1936), determinable plant remains are nowhere abundant, and with the exception of an occasional specimen the flora is poorly preserved. Under ordinary circumstances any revision of the Esmeralda would at best be largely tentative. However, by comparing it with the Miocene Tehachapi flora 200 miles southwest and the Lower Pliocene Truckee floras 110 and 150 miles north, it has been possible to arrive at a more accurate evaluation of the Esmeralda species for nearly all of them occur in those beds. The following 16 plants are considered to represent the Esmeralda flora:

SYSTEMATIC LIST OF SPECIES

- PTERIDOPHYTA:
  - POLYPODIACEAE:
    - *Dryopteris obscura* (Knowlton) Berry.
- SPERMATOPHYTA:
  - GYMNOSPERMAE:
    - Cupressaceae:
      - *Juniperus nevadensis*, n. sp.
  - ANGIOSPERMAE:
    - Monocotyledonae:
      - Cyperaceae:
        - *Cyperacites* sp
    - Dicotyledonae:
      - Salicaceae:
        - *Populus alexanderi* Dorf.
        - *Populus nevadensis* (Knowlton) Axelrod, n comb.
        - *Salix kernensis* Axelrod.
        - *Salix vaccinifolia* Knowlton
      - Fagaceae:
        - *Quercus pollardiana* (Knowlton) Axelrod, n. comb.
        - *Quercus turneri* Knowlton.
      - Ulmaceae
        - *Celtis lacustris* (Knowlton) Axelrod, n comb.
      - Berberidaceae
        - *Mahonia marginata* (Lesquereux) Arnold.
      - Lauraceae:
        - *Umbellularia salicifolia* (Lesquereux) Axelrod.
      - Nymphaeaceae:
        - *Nymphaeites nevadensis* (Knowlton) Brown.
      - Rosaceae:
        - *Cercocarpus cuneatus* Dorf.
        - *Prunus nevadensis* (Knowlton) Axelrod, n. comb.
      - Ericaceae
        - *Arctostaphylos preglauca* Axelrod.

The presumed relationships of the 13 woody plants to modern species are indicated below. The rush (*Cyperacites*), water-lily (*Nymphaeites*), and fern (*Dryopteris*) have not been included because they are represented by material too lacking in diagnostic characters to warrant reference to any living species.

Fossil Species	Nearest Related Modern Equivalents
Arctostaphylos preglauca	*A. glauca*
Celtis lacustris	*C. reticulata*
Cercocarpus cuneatus	*C. betuloides*
Juniperus nevadensis	*J. utahensis* (*californica*)
Mahonia marginata	*M. fremontii*
Populus alexanderi	*P. trichocarpa*
Populus nevadensis	*P. tremuloides*
Prunus nevadensis	*P. andersonii*
Quercus pollardiana	*Q. chrysolepis*
Quercus turneri	*Q. turneri*
Salix kernensis	*S. bonplandiana* var. *toumeyi*
Salix vacciniifolia	*S. exigua*
Umbellularia salicifolia	*U. californica*

Oaks dominated the fossil flora and together with the juniper comprised a savanna-woodland community whose regular associates include the mountain mahogany (*Cercocarpus*), barberry (*Mahonia*), manzanita (*Arctostaphylos*), and desert peach (*Prunus*). The remainder are either hygrophilous, such as the water-lily (*Nymphaeites*) and rush (*Cyperacites*), or are forms largely inhabiting stream banks in arid regions.

Although seven of these plants have survived down to the present in the White Mountains 30 miles west of the fossil locality, and nine of them commonly occur along the desert slopes of southeastern California, there are two regions in particular that are significant, as shown in table 1.

TABLE 1.—DISTRIBUTION OF THE NEAREST RELATED MODERN EQUIVALENT SPECIES OF THE ESMERALDA FLORA

Species	White Mountains	Desert Slopes, Southeastern California	Kern River Canyon	Southern Arizona
Arctostaphylos glauca			x	
Celtis reticulata	x	x	x	x
Cercocarpus betuloides	x	x	x	x
Juniperus utahensis	x	x	x	x
Mahonia fremontii		x		x
Populus tremuloides	x	x		x
Populus trichocarpa	x	x	x	
Prunus andersonii	x	x	x	
Quercus arizonica				x
Quercus chrysolepis		x	x	x
Salix bonplandiana				x
Salix exigua	x	x	x	x
Umbellularia californica			x	
Total: 13	7	9	9	9

The flora of the middle Kern River canyon area is characterized by oaks and juniper scattered over the canyon slopes, with the willow, hackberry, California laurel, and desert peach limited to the stream banks. Two of these plants, the California laurel and manzanita, clearly form a climatically sensitive unit in the flora, for they do not range with the remaining species onto the desert slopes where conditions are more extreme. Nevertheless, it is to be emphasized that the *Arctostaphylos* and *Umbellularia* are approaching desert-border conditions in the Kern River canyon This is shown by the occurrence of *Prunus andersonii* in the area, in addition to such typical desert species as *Encelia frutescens*, *Ephedra nevadensis*, *Hymenoclea salsola*, *Lycium andersonii*, and *Tetradymia spinosa* (Coville, 1893, p. 8). It seems clear that conditions now obtaining in areas of the southern and interior distribution of the manzanita and California laurel approximate the Esmeralda climate. Although the aspen does not occur in the central Kern River canyon area, it grows under a wide range of conditions in western North America The writer has observed it in eastern California and western Nevada with many plants having equivalent species in the Esmeralda flora. It may be recalled that the aspen has been recorded in the Pliocene Mount Eden flora of southern California (Axelrod, 1937), where it is associated with five plants that occur also in the Esmeralda.

Nine of the modern equivalents of the flora may be found in southern Arizona, where they also form part of the woodland community, but the California laurel, black cottonwood, manzanita, and desert peach are absent. However, the desert peach is replaced here by *Prunus fasciculata*, one of its common associates in southeastern California, and both the cottonwood and manzanita are represented in southern Arizona by species having somewhat similar ecological requirements. Since the climate of southern Arizona differs from that of California in its biseasonal distribution of rainfall, the willow (*Salix bonplandiana*) and oak (*Quercus arizonica*) limited to this area clearly represent another climatically important group in the flora It is critical that both have fossil representatives in the Miocene Tehachapi flora (Axelrod, 1939), and that they lived in California at a time when rainfall had a distribution of the present southern Arizona type. Additional plants in the Esmeralda flora occurring also in the Tehachapi include all species except the juniper (*Juniperus nevadensis*), manzanita (*Arctostaphylos preglauca*), and willow (*Salix vaccinifolia*), but all these would also form a consistent element in that flora. The persistence of these plants into the later Tertiary in the southern Great Basin shows clearly that they form a floristic group which has been segregated into regions now isolated by desert in comparatively recent geologic time (Axelrod, 1939, p. 65).

Since the conditions in the Kern River canyon and in southern Arizona are considered to most nearly approximate the climate of Esmeralda time, it is desirable to compare briefly the climate of these areas with that now prevailing at Esmeralda. Present conditions at the fossil locality, as judged from data for Mina 25 miles north and at the same elevation, are as follows:

Annual rainfall	4 inches
Average annual temperature	54°F.
Average July maximum temperature	95°F.
Average January minimum temperature	19°F.
Highest temperature recorded	109°F.
Lowest temperature recorded	22°F.

Although precipitation at Esmeralda amounts to only 4 inches annually, it ranges from 12 or 14 to as much as 18 inches in areas where vegetation resembles the fossil flora From these data it is clear that annual rainfall has been lowered about 10 inches since Esmeralda time. Temperature data are more difficult to evaluate, but the following points seem worthy of note: (a) Average annual temperatures in areas showing relationship to the fossil flora are about 5°F. higher than those now at Esmeralda; (b) average maximum summer temperatures are 4° or 5°F. lower, and average January minimum temperatures are from 5° to 10°F. higher, in areas where the fossil flora has the greatest proportion of its nearest related species; (c) extreme summer temperatures are nearly alike in all of the areas; (d) extreme winter temperatures are at least 30°F. higher in areas where the Esmeralda has its greatest relationship to modern vegetation.

From this brief consideration of the floristic and climatic relationships of the Esmeralda flora, it may be concluded that the arid basin was surrounded by an oak-juniper community whose associates included species of barberry, manzanita, mountain mahogany, and desert peach. Growing along the streams that flowed into the lake, and about its margins, were species of hackberry, California laurel, aspen, cottonwood, and willow Rushes and ferns formed dense communities along the borders of the lake, which also supported colonies of water-lily Although the occurrence of *Prunus nevadensis* in the flora suggests that certain members of the sagebrush formation may have occupied drier sites over the area, the predominance of grazing vertebrates in the formation indicates grassland was dominant. Rainfall was in the neighborhood of 12 to 15 inches annually and was distributed as summer thundershowers and winter rains. This is shown by the presence of the southern oak (*Quercus turneri*), willow (*Salix kernensis*), and barberry (*Mahonia marginata*) in the flora, and by the occurrence also in relatively contemporaneous floras to the north and south, of fossil species which may be referred to such characteristic southern plants as walnut (*Juglans rupestris*), locust (*Robinia neo-mexicana*), oak (*Quercus hypoleuca*), ash (*Fraxinus velutina*), and soapberry (*Sapindus drummondii*). In addition, it is to be pointed out that the early Pliocene floras of central California provide ample evidence of summer precipitation (Axelrod, 1939, p. 56; Axelrod, 1940). It is to be expected that rainfall was distributed biseasonally in western Nevada at this time, when the present Sierra Nevada barrier at the west was a relatively low mountain range. Temperature conditions in the Esmeralda area were more nearly like those now found on the western slopes of the southern Sierra Nevada and in southern Arizona, which differ most from the present Nevada climate in having considerably milder winters.

The lowering of rainfall 10 inches in post-Esmeralda time and the more extreme winter temperatures at the fossil locality are reflected clearly in the character of the modern flora, for all the area is Great Basin Sagebrush (Clements, 1920) Although scattered junipers occur in the Silver Peak Range several miles south, the nearest forest cover of any considerable extent is at higher elevations in the White Mountains along the California–Nevada boundary 30 miles west. The major factor accounting for the restriction of tree growth into the higher mountains has been the decrease in rainfall due to the interception of rain-bearing winds by the rising Sierra Nevada barrier at the west. The delimitation of the interior region resulted also in greater extremes of winter temperature, and these have played an important role in limiting such plants as the California laurel and manzanita to the western slopes of the Sierra Nevada. Plants whose modern representatives now occur in the southwestern United States and northern Mexico were eliminated gradually as summer thundershowers disappeared over the western portion of the province Although this floristic evolution over the area has already been outlined (Axelrod, 1939a), it will be discussed in detail after the floras over the region, which are distributed from southern Oregon southward for 800 miles into the Mohave Desert, have been more thoroughly studied.

There is no need of reviewing here the various ideas with respect to the age of the Esmeralda formation It is sufficient to point out that Stirton has recently summarized the vertebrate evidence (1936), and places the formation in the Lower Pliocene (p. 183) Paleobotanical data point also to a Lower Pliocene age for the flora. The absence of the typical Miocene Asiatic and broad-leaved deciduous genera in the flora definitely establishes its Pliocene age (Chaney, 1936, 1936a, 1938). Whereas such Miocene genera as *Cebatha, Nelumbo, Trapa,* and *Zelkova* occur in the Coal Valley flora 75 miles northwest, none of them are known to appear in the Esmeralda flora. Their absence here indicates its post-Coal Valley age, a fact consistent with the occurrence of vertebrates representing the *Nannippus tehonensis* zone (Uppermost Miocene or basal Pliocene) at Coal Valley.[2] Although characteristic Miocene genera and species are known to have survived into the Middle Pliocene of west-central California under the influence of moderating coastal conditions (Axelrod, 1940), are abundant in the early Pliocene along the windward slopes of the Sierra Nevada 140 miles west (Condit), and have been recorded from the basal Pliocene of the northern Great Basin (Dorf, 1936), they are known only to have persisted as occasional relicts into the Pliocene of west-central Nevada. It is to be expected that the later Tertiary floras of the western Great Basin, situated on the leeward side of the rising Sierra Nevada barrier, would show a reduction in the regular members of the northern Miocene elements earlier in the epoch than floras on the windward

[2] R. A Stirton, oral communication, 1939

slopes of the range or to northward. The replacement of the northern Miocene elements by plants whose modern descendants now occur in the southwestern United States and northern Mexico, is a regular feature of the Lower Pliocene floras of this area (Axelrod, 1938, 1939), and clearly indicates the age of the Esmeralda flora.

The Esmeralda is intermediate in its composition and climatic indications with respect to the Ricardo flora 175 miles south (Webber, 1933; Axelrod, 1939, pp. 78–84), and the Lower Pliocene Truckee flora at Fallon now under investigation, which lies 110 miles northwest. The Ricardo is dominated by oaks[3] and these appear to have formed a savanna community Fan-palms and locust occurred along the streams in this area, and from higher elevations cypress and pinyon pine contributed occasional stem fragments to the Ricardo deposit. The climate at Ricardo during Lower Pliocene time was characterized by high ranges of temperature and a yearly rainfall of from 10 to 14 inches, distributed as summer thundershowers and winter rains. The Truckee flora at Fallon is dominated also by an oak-juniper community, and the hackberry, cottonwood, and willow occur here as well. A limited representation of the montane forest (*Pinus, Abies, Arbutus, Castanopsis, Amelanchier*) at Fallon shows that the climate in this area, which lies 110 miles northwest, received a greater amount of rainfall and had lower ranges of temperature than the Esmeralda region.

From these relationships it is possible to conclude that the lowlands over the area from Fallon southward into the Mohave Desert were characterized by a woodland formation during Lower Pliocene (Axelrod, 1939a). Northward, where annual rainfall ranged from 14 to 17 inches in the lowlands, members of the montane forest were limited to the adjacent hills Precipitation decreased southward, limiting members of the montane forest to higher elevations, and in the western Mohave area, as well as along the borders of the Colorado Desert (Axelrod, 1937), plants of desert-border character occurred in the woodland region which had a rainfall of from 10 to 14 inches yearly.

Conclusions.—(1) Recent collections of later Tertiary vegetation over the Great Basin have shown that the Esmeralda flora described by Knowlton is distinct from the Coal Valley flora reported by Berry, which is located 75 miles northwest.

(2) The Esmeralda flora contains 16 species, including a fern, two aquatics, and 13 trees and shrubs whose nearest related modern descendants now form an oak-juniper community. The assemblage displays a close relationship to modern vegetation now living in southern Arizona and along the western slopes of the southern Sierra Nevada.

(3) In its climatic and floristic relationships, the Esmeralda is intermediate with respect to the Ricardo flora at the south and the Fallon flora to the north.

[3] Continued excavations at the Ricardo Petrified Forest have shown oak to be the dominant species.

(4) Whereas the Esmeralda is of Lower Pliocene age, the Coal Valley flora contains members of the northern Miocene forest flora and is of Uppermost Miocene age.

SYSTEMATIC DESCRIPTIONS[4]

Family Polypodiaceae

Dryopteris obscura (Knowlton) Berry

Dryopteris obscura (Knowlton) Berry, Proc. U. S. Nat Mus **72**(15): 5. 1927

Fragments of fern pinnae are exceedingly abundant in the shales associated with the coal workings at the base of the formation south of Coaldale

Family Cupressaceae

Juniperus nevadensis, n sp.

A twig 3 cm long and 1 mm wide, with closely appressed leaves, apparently in whorls of three, is clearly that of juniper.

On the basis of foliage alone it is not possible to indicate relationship to any one modern species of the genus now in western North America. From an ecological standpoint, however, this material seems referable to the modern *Juniperus californica* Carriere of California or to *J. utahensis* Lemmon of the Great Basin area. The montane *J. occidentalis* does not come under consideration for it is regularly associated with plants whose fossil equivalents have only a rare representation in this flora. Accordingly, the Esmeralda material is recognized as distinct from *Juniperus sabinoides* Ashlee of the Latah and Wieser floras because it is believed to represent a different species The northern juniper seems comparable to the western *J. occidentalis* Hooker rather than to the more arid *J californica* and *J. utahensis*. *Juniperus nevadensis* is represented also in the Fallon flora 110 miles north and will be figured when this flora is completed

Family Cyperaceae

Cyperacites sp.

Remains of rushlike or reedlike plants, so lacking in diagnostic characters that relationship to any one modern genus is questionable, are common in the shales throughout the section and are particularly abundant in the lower part of the formation associated with the coal seams. These dense tangled masses suggest a habitat somewhat similar to the present sedge- and rush-covered borders of lakes and marshes throughout the arid portions of the western United States.

Family Salicaceae

Populus alexanderi Dorf

Populus alexanderi Dorf, Carnegie Inst. Washington Publ. **412**: 75–77, pl. 6, figs. 10, 11 (not fig. 9, which is *Populus prefremontii* Dorf); pl. 7, figs. 2, 3 (not fig. 1, which is *Populus prefremontii* Dorf). 1930.

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[4] All species except the juniper, which is in the paleobotanical collections at the University of California, are represented in the collections at the United States National Museum Although 4 new combinations are presented, it has seemed desirable not to place in synonymy 3 species that may be shown eventually to belong here: *Populus nevadensis* = *P. pliotremuloides* Axelrod, *Quercus pollardiana* = *Q. hannibali* Dorf, *Celtis lacustris* = *C. kansana* Chaney and Elias This synonymy has been delayed until a more complete and diagnostic Esmeralda collection can be obtained.

A well-preserved specimen among the undetermined Esmeralda material at the United States National Museum represents this species, which is closely similar to the living *Populus trichocarpa* Torrey and Gray of the Western United States.

Populus nevadensis (Knowlton) Axelrod, n. comb

Cercis nevadensis Knowlton, U. S. Geol. Surv. Ann. Rept. **21**(2): 217, pl. 30, fig. 23. 1900.

The leaf figured as *Cercis* is clearly that of an aspen, and another basal fragment among the unidentified material of the Esmeralda flora is also referred to the Pliocene species.

Salix kernensis Axelrod

Salix kernensis Axelrod, Carnegie Inst Washington Publ. **415**: 90–91, pl. 6, fig. 7. 1939.

Salix vaccinifolia Knowlton (in part), U. S. Geol. Surv. Ann. Rept. **21**(2): 212, pl. 30, fig. 20 only (not fig. 8, which remains *Salix vaccinifolia*). 1900.

Salix angusta Al Braun, Knowlton, Idem. 212, pl. 30, fig. 22.

Salix sp. Knowlton, Idem: 213, pl 30, fig. 13.

All these specimens are clearly of the same type and differ in no manner from the Tehachapi species. Two of the Esmeralda species were figured incorrectly. *Salix vaccinifolia* (fig. 20) should have long, thin and looping secondaries like those of *Salix* sp. in figure 13. The margins of the specimen figured as *Salix angusta* are entire, not serrate, and the secondaries are likewise long, looping, and thin.

This material compares rather closely with the entire-margined forms of *Salix bonplandiana* Humboldt, Bonpland, and Kunth, of the southwestern United States and northern Mexico, and particularly with the variety *toumeyi* of southern Arizona.

Salix vaccinifolia Knowlton

Salix vaccinifolia Knowlton, U S. Geol Surv. Ann. Rept. **21**(2): 212, pl 30, fig. 8 only (not fig. 20, which is *Salix kernensis* Axelrod). 1900.

Knowlton originally pointed out the close resemblance between this specimen and the smaller leaves produced by the modern *Salix exigua* Nuttall of the Western United States.

Family FAGACEAE

Quercus turneri Knowlton

Quercus turneri Knowlton, U. S. Geol. Surv. Ann. Rept. **21**(2): 214, pl. 30, fig. 21. 1900.—Axelrod, Carnegie Inst. Washington Publ. **516**: 100, pl 7, figs. 10, 11, 14. 1939.

Quercus argentum Knowlton, U S. Geol. Surv. Ann. Rept. **21**(2): 215, pl. 30, fig. 12. 1900.

Cinchonidium? turneri Knowlton, Idem: 218, pl. 30, figs. 9–11.

All this material is one botanic species and forms the dominant of this flora. Among modern plants there is a close relationship to *Quercus arizonica* Sargent of the Southwestern United States.

Quercus pollardiana (Knowlton) Axelrod, n. comb.

Chrysobalanus pollardiana Knowlton, U. S. Geol. Surv. Ann. Rept. **21**(2): 216, pl. 30, fig. 19. 1900.

The *Chrysobalanus* may be matched by the large oval leaves of *Quercus chrysolepis* Liebmann (see sheet nos. 1521956, 667634, 319924, 319884 in the United States National Herbarium).

Family ULMACEAE

Celtis lacustris (Knowlton) Axelrod, n. comb.

Ficus lacustris Knowlton, U. S. Geol. Surv. Ann. Rept. **21**(2): 215, pl. 30, fig. 26 1900.

Although Berry has placed *Ficus lacustris* in the genus *Populus* (1927, p. 9), Chaney and Elias (p. 22) have pointed out its resemblance to hackberry Comparison of the type material with the leaves of the modern *Celtis reticulata* reveals no differences between them. The specimen is entire-margined, not serrate as figured.

Family BERBERIDACEAE

Mahonia marginata (Lesquereux) Arnold

Mahonia marginata (Lesquereux) Arnold, Contr. Mus. Pal. Univ. Michigan **5**(4): 64–65 1936.

Odostemon marginata (Lesquereux) Knowlton, U S Geol Surv. Prof. Paper **131**: 189, pl 43, figs. 7–10 1923.

Although there appears to be a gradation between this species and *M. hakaefolia* (Lesquereux) Arnold, they may be distinct. The typical leaflets of *M. hakaefolia* are similar to those produced by the modern *M. trifoliata* Fedde, which regularly has two or three lateral teeth and a slender shape. The leaflets of *M. marginata* are more nearly like those of the modern *M. fremontii* Torrey in that they are broader, the sinuses are shallower, and the teeth are not so large and heavy By this definition, the leaves figured by Arnold as *M. hakaefolia* would belong more properly to *M. marginata*. It is hoped that further collections from the Creede flora, where both of these species are represented, will settle this problem.

Family LAURACEAE

Umbellularia salicifolia (Lesquereux) Axelrod

Umbellularia salicifolia (Lesquereux) Axelrod, Carnegie Inst. Washington Publ **516**: 102–103, pl. 8, fig. 4. 1939. (See synonymy.)

Salix? sp. Knowlton, U S Geol Surv Ann. Rept. **21**(2): 213–214, pl. 30, fig 14. 1900

A relatively large leaf in the writer's collection, in addition to the small willowlike leaf figured by Knowlton, seems properly referable to *Umbellularia*.

Family NYMPHAEACEAE

Nymphaeites nevadensis (Knowlton) Brown

Nymphaeites nevadensis (Knowlton) Brown, Journ. Washington Acad. Sci. **27**: 509, pl. 1, fig. 10. 1938 (See synonymy)

The water-lily is not only represented at the type Esmeralda locality, but is exceedingly abundant in the Coal Valley flora where it forms a regular associate of *Nelumbo, Equisetum, Trapa, Typha,* and other hygrophilous plants.

Family ROSACEAE

Cercocarpus cuneatus Dorf

Cercocarpus cuneatus Dorf, Carnegie Inst. Washington Publ. **412**: 98–99, pl. 12, fig. 3. 1930.

The upper portion of a leaf impression in the undetermined Esmeralda material at the United States National Museum is clearly that of the mountain mahogany.

Prunus nevadensis (Knowlton) Axelrod, n. comb.

Rhus? nevadensis Knowlton, U. S. Geol Surv. Ann. Rept. **21**(2): 218, pl. 30, fig. 15. 1900.

The leaf figured as *Rhus nevadensis* has been incorrectly illustrated because the margin is serrate and the lower secondaries loop well into the upper part of the blade. An additional unfigured specimen is clearly of the same type, but is about two-thirds as large Both of these specimens are indistinguishable from the leaves produced by the modern *Prunus andersonii* Gray of the Great Basin area

Family ERICACEAE

Arctostaphylos preglauca Axelrod

Arctostaphylos preglauca Axelrod, Carnegie Inst Washington Publ. **476**(3): 178, pl. 6, figs 8, 9. 1937

A single leaf among the undescribed Esmeralda material is clearly that of manzanita Although it has been referred to this Mount Eden species, which is related closely to the living *Arctostaphylos glauca* Lindley, it shows affinity also to such species as *A pringlei* Parry of southern Arizona and *A. glandulosa* Eastwood of California. Although further collections may show this Esmeralda manzanita to be a new species, it seems clear that it has its relationships among species no longer occurring over the Great Basin area

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PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE ACADEMY

42D ANNUAL MEETING

The 42d Annual Meeting of the Washington Academy of Sciences was held in the Assembly Hall of the Cosmos Club, January 18, 1940, with 47 members present President Charles E Chambliss called the meeting to order at 9:45 p m. The minutes of the 41st Annual Meeting were presented and approved as published in the Journal The Corresponding Secretary, Nathan R Smith, submitted the following report on the membership and activities of the Academy:

During 1939, 52 were elected to resident, 9 to nonresident active membership, and 6 to honorary membership Of the 52 for resident membership, 34 had become members in good standing at the end of the year, 2 had declined membership, 3 had not replied to our letters, and 13 had accepted membership but had not paid their dues (most of these were elected in December) Of the 9 elected to nonresident membership, 5 qualified, 1 declined, 3 have not replied as yet Of those who accepted membership in 1939, 14 were elected in recognition of their work in Chemistry; 6 in Botany; 5 each in Entomology, Bacteriology, and Medicine; 2 each in Physics, Biology, Zoology, and Ichthyology; and 1 each in Geology, Soil Science, Helminthology, Pharmacology, Genetics, Statistics, Education, Food Research, and Ethnology There were 4 resignations, 3 in the resident and 1 in the nonresident membership Five resident and 3 nonresident members were dropped for nonpayment of dues. Because of their retirement from professional work, 4 resident and 5 nonresident members were considered active members without the payment of dues.

There were 9 deaths during the year, 4 resident and 5 nonresident members, as follows:

George H Girty, resident, on January 27, 1939
Edmund C. Shorey, resident, on January 30, 1939.
W. D. Bigelow, resident, on March 3, 1939.
J. G Lipman, nonresident, on April 19, 1939
Joseph Grinnell, nonresident, on May 29, 1939.
Wendell C. Mansfield, resident, on July 24, 1939.
Harvey W. Cushing, nonresident, on October 7, 1939.
Waldemar Lindgren, nonresident, on November 3, 1939
E. E. Free, nonresident, on November 24, 1939.

To summarize, on January 1, 1940, the membership consisted of 17 honorary members, 3 patrons, and 572 active members, of which 2 are life members. Of the active members, 43 (29 resident and 14 nonresident) do not pay dues because of retirement. There were, therefore, 529 active members who pay dues, 411 resident and 118 nonresident. Since the number of resident members is limited to 450 and the nonresident to 200, there were 39 vacancies in the resident and 82 in the nonresident.

The status of the resident active membership is satisfactory. The large number of vacancies is due to the fact that the limitation was raised from 400 to 450 by vote of the membership in July. As was stated above, 13 duly accepted, but there was not time for the collection of dues before January 1. In addition, 15 have been recommended for membership by the Committee on Membership and may be acted upon at the next meeting of the Board of Managers. There are, therefore, potentially only 11 vacancies in the resident membership.

The status of the nonresident membership is progressively unsatisfactory owing to the small number elected.

The Board of Managers had a very busy year, holding 9 meetings with an average attendance of 18. In addition to the routine business of the Academy, the Board authorized the appointment of the following special committees, all of which completed their work and reported to the Board·

On Editorial Assistant: Chairman, J A STEVENSON
To Consider Publishing Red Book: Chairman, W. A DAYTON
On Ways and Means for Selling Complete Sets of the Journal: Chairman, H. E EWING.
Memoirs and Awards: Chairman, J. F. COUCH.
To Finish Cataloging the Scientific Societies of Washington and to Define Qualifications of a Society for Affiliation and to State the Advantages of Affiliation to the Society: Chairman, W T. SCHALLER.
To Review the Bylaws and Make Recommendations: Chairman, F. C. KRACEK.
To Consider the Revision of the Bylaws and to Make Definite Recommendations to the Board of Managers. Chairman, W. A. DAYTON.
On Awards: Subcommittee for Biological Sciences: Temporary Chairman, E. A. GOLDMAN.
  Subcommittee for Physical Sciences. Temporary Chairman, J F. COUCH
  Subcommittee for Engineering Sciences: Temporary Chairman, H. L. CURTIS.
On Monographs: Temporary Chairman, H. B COLLINS, JR.
On Certificate of Award: Chairman, H B. HUMPHREY.

By authorization of the Board, the President appointed W. W. DIEHL Custodian and Subscription Manager of Publications for 3 years.

On motion it was voted to accept the Corresponding Secretary's report and to place it on file.

The Recording Secretary, OSCAR S. ADAMS, presented the following report:

The 42d year of the Academy began with the 290th meeting and ended tonight with the 295th meeting. All the six meetings of the year were held in the Assembly Hall of the Cosmos Club.

The 290th meeting was held on February 16, 1939. An illustrated address was given by WALDO L. SCHMITT, curator, Division of Marine Invertebrates, U. S. National Museum, Smithsonian Institution, on the subject *The Galapagos Islands*. Attendance about 200.

The 291st meeting was held on March 16, 1939. An illustrated address was given by ENRICO FERMI, Columbia University, New York City, on the subject *The Mesotron*. Attendance about 200.

The 292d meeting was held on April 20, 1939. An illustrated address was given by **Wilton Marion Krogman**, associate professor of anatomy and physical anthropology, University of Chicago, on the subject *The Skeleton Tells Its Story*. Attendance about 170.

The 293d meeting was held on November 16, 1939 The address was given by Maj. Gen. **Hanson E. Ely**, former commandant of the Army War College, on the subject *Improvements in War Weapons since the World War and in Methods of their Use*. Attendance 103

The 294th meeting occurred on December 21, 1939. The address was given by **Carl S. Marvel**, professor of organic chemistry, University of Illinois, on the subject *Plastic Glasslike Resins* (*Vinyl Polymers*). Samples of many of the Polymers were shown and their properties discussed Attendance about 200

The 295th meeting was held on January 18, 1940. The address was given by the retiring President of the Academy, **Charles E. Chambliss** of the Bureau of Plant Industry, U. S. Department of Agriculture, on the subject *The Botany and History of Zizania aquatica L.* Attendance 123.

This was the final meeting of the 42d year of the Academy.

On motion it was voted to accept the Recording Secretary's report and to place it on file.

The report of the Treasurer, **H. G. Avers**, was read by **Howard S. Rappleye**:

CASH RECEIPTS AND DISBURSEMENTS

RECEIPTS:		
From back dues	$ 140.00	
From dues for 1939	2,450.00	
From dues for 1940	40.00	
From subscriptions for 1939	432.30	
From subscriptons for 1940	236.10	
From sales of Journals	227.26	
From payments for reprints	450.94	
From sales of 1937 Directory	1.15	
From sales of 1939 Directory	108.00	
From interest on deposits.	95.82	
From interest on investments	940.60	
Total receipts	$5,122.17	
Cash Balance January 1, 1939	1,514.94	
To be accounted for		$6,637.11
DISBURSEMENTS:		
For Secretary's Office, 1938	$ 117.70	
For Secretary's Office, 1939	227.20	
For Treasurer's Office.	188.15	
For Journal printing, 1938	281.78	
For Journal printing, 1939	2,417.25	
For Journal reprints, 1938	70.88	
For Journal reprints, 1939.	558.18	
For illustrations, 1938.	39.58	
For illustrations, 1939	402.61	
For Journal Office, 1938.	36.88	

For Journal Office, 1939...		202.42	
For Meetings Committee, 1938		25.00	
For Meetings Committee, 1939		238.05	
For Directory		702.59	
For dues of retired members returned		10.00	
For refund of overcharge on reprints		3.60	
Bank debit memos, as follows:			
Dues	$0.35		
1939 Subscriptions	.50		
1940 Subscriptions	.08	.93	
Deposited in savings account		95.82	
Total disbursements		$5,618.62	
Cash balance December 31, 1939		1,018.49	
Total			$6,637.11

RECONCILIATION OF BANK BALANCE

Balance as per cash book, December 31, 1939			$1,018.49
Bank balance, American Security & Trust Co per statement of December 31, 1939		$1,158.48	
Receipts not deposited		76.00	
		$1,234.48	
Checks outstanding, not cashed			
No. 170	$ 21.50		
No 571	9.12		
No 575	6.00		
No. 576	179.37		
Total		215.99	
Balance			$1,018.49

Check No 170 listed as outstanding was issued in May 1934 but has not been cashed

INVESTMENTS

409 shares stock of Washington Sanitary Improvement Co, par value $10 per share, cost	$ 4,090.00
20 shares stock Potomac Electric Power Co, 6% Pref.; cost	2,247.50
1 bond of Interborough Rapid Transit Co, no 37020, interest at 5%; due Jan. 1966; par value $1,000, cost	995.00
*1 bond of Chicago Railways Co., no. 1027; interest at 5%, due 1927; par value $1,000 less $250; cost	713.87
1 real-estate note of T. Q. Donaldson (no 6 of 12) dated June 26, 1937, for 3 years; interest at 5%; cost	1,000.00
2 real-estate notes of Yetta Korman et al., dated Oct. 5, 1938, for 3 years (no. 7 of 37 for $500, and no. 8 of 37 for $500), interest at 5%; cost	1,000.00

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* The bond of the Chicago Railways Co. was not paid upon maturity due to the expiration of franchise and failure of the Legislature to enact continuing legislation; interest has been paid to date under authority of the courts, and $250 has been paid on the principal since maturity

3 real-estate notes of Ell & Kay Bldg. & Investment Co., dated Oct. 15, 1938, for 3 years (no. 75 of 165 for $2,000, no. 83 of 165 for $1,000, and no 101 of 165 for $1,000); interest at 5%; cost	4,000.00
Butler notes—Property at 1707 L St., NW , bought in by note holders—Academy's share 4/250ths; interest amounting to $40 received in 1939; cost.	2,000.00
	$16,046.37
Deposited in savings account, American Security & Trust Co	8,409.94
Total	$24,456.31
Cash-book balance December 31, 1939	1,018 49
Total assets	$25,474 80

ALLOTMENTS

	Allotted Receipts	*Expended*
Secretary's Office	$ 450.00	$ 227.20 (1)
Treasurer's Office	225 00	188.15
Journal	2,500 00+$1,444 20=$3,944 20	3,580.46 (2)
Meetings Committee	350 00	238 05 (3)
Membership Committee	10 00	——
Executive Committee	10 00	——
Directory	700 00+$108 00=$808 00	702 59

Bills outstanding, not paid, at end of year (estimated)·

(1) Secretary's Office	$ 30 00
(2) Journal	280.00
(3) Meetings Committee	110 00

The Auditing Committee. H G Dorsey, Paul Whitney, and Elmer Higgins, reported

Your committee appointed to audit the accounts of the Treasurer of the Washington Academy of Sciences for the year 1939 submits the following report:

The Treasurer's records of receipts and expenditures as shown in his account books and included in his report have been examined and found correct. All vouchers have been examined and found to be correct and properly approved.

The balance sheets submitted by the bank and the securities listed in the Treasurer's report have been examined The statement of the assets of the Academy was found correct.

No coupons not yet due were missing from any of the securities bearing coupons.

The records of the Treasurer's office have been carefully and systematically kept, thus greatly facilitating the work of the auditing committee.

The auditing committee congratulates the Treasurer on the manner in which he has carefully conducted his office during his long faithful tenure.

It was moved to accept the reports of the Treasurer and the Auditing Committee and to place them on file. By vote it was so ordered.

The Board of Editors, F. D. Rossini, C. L. Gazin, and J. H. Kempton, submitted the following report:

I. NATURE AND AMOUNT OF THE MATERIAL PUBLISHED

Volume 29 consists of 560 pages, as compared with 556, 548, 554, 588, 576, 588, 572, and 552 pages, respectively, for the years from 1938 back to 1931.

The space in volume 29 was distributed as follows:

Class	*Subject*	*Number of papers*	*Number of pages*
Biology	Anthropology	1	5.60
	Biology	1	14.00
	Botany	8	49.22
	Entomology	7	77.55
	Evolution	1	20.00
	Ichthyology	2	25.83
	Malacology	2	4.15
	Mammalogy	2	3.55
	Medical Entomology	1	5.90
	Ornithology	3	7.85
	Plant Physiology	1	15.00
	Zoology	6	57.21
Geology	Geology	2	18.50
	Paleobotany	4	18.90
	Paleontology	7	60.25
Chemistry	Chemistry	2	14.15
	Geochemistry	1	5.25
	Physical Chemistry	1	25.30
Physics	Biophysics	1	6.85
	Geophysics	1	30.00
	Physics	2	29.15
Obituary		7	5.00
Scientific News and Notes		1	0.70
Index	Authors		4.00
	Subjects		4.00
Proceedings	Academy		10.40
	Botanical Society		5.75
	Chemical Society		13.00
	Geological Society		5.65
	Philosophical Society		14.25

Divided as above, the various classes of material occupied the following percentages of the total space in the Journal:

Class	*No. of papers*	*Percentage*
Biology	35	51.0
Geology	13	17.6
Chemistry	4	8.1
Physics	4	11.9
Obituary		0.9
Scientific News and Notes		0.2
Proceedings		8.8
Index		1.5

Of the 56 original scientific papers, 36 were written by members of the Academy and 20 were communicated

II. AMOUNT AND DISTRIBUTION OF INCOME AND EXPENDITURES

Income

From the Academy	$2,500.00
From subscriptions	740.10
From sales of back numbers	216.42
Total	$3,456.52

Expenditures

	Cost	*Charged to authors or sponsors*	*Charged to the Academy*
Printer's office:			
Printing, binding, mailing, etc	$2,618.59	$ 8.72	$2,609.87
Engravings	409.90	143.01	266.89
Reprints	568.07	306.22	261.85
Editor's office:			
Postage and miscellaneous	43.14	—	43.14
Clerical assistance	180.00	—	180.00
Total	$3,819.70	$457.95	$3,361.75
Unexpended balance			$ 94.77

The amount actually expended by the Academy in maintaining the Journal for the year 1939, which is the amount allotted to the Journal by the Academy less the unexpended balance returned to the Academy by the Journal, was $2,405.23

The report of the Board of Editors was accepted and ordered placed on file

The following report was submitted by the Custodian and Subscription Manager of Publications, W W. Diehl:

On December 1 a report was made to the Board of Managers recording the result of an inventory of stocks made on November 13 This inventory showed the surprising fact that there was then but one complete set of the Journal available for sale in respect to volumes 1, 2, and 3; and in the case of the next 12 volumes in no instance over nine sets to the volume. Personal inquiry at the Waverly Press, Baltimore, where they are stored, revealed that this very small number of old volumes was due to the elimination in 1937 of most of the old stocks save a very small number of which some have since been sold. Because of this limited number of the older volumes of the Journal some changes in policy seemed needful. The Board on December 1, therefore, ordered the reservation from sale except as parts of complete sets of all numbers in volumes 1–15 It is hoped that additional numbers of the limited 15 volumes may be donated to the Academy in order to make more complete sets available for sale in compliance with this Board action.

The Custodian and Subscription Manager has planned a course of action in soliciting new subscriptions, but no action has yet been taken because it is dependent upon the allotment of funds in the 1940 budget.

By vote the report of the Custodian and Subscription Manager of Publications was accepted and ordered placed on file.

The following report on awards and memoirs was submitted by President Chambliss.

BYLAWS

Article VII—Recognition of Merit in Scientific Work

Section 1. The Academy may award medals and prizes or otherwise express its recognition and commendation of scientific work of high merit and distinction.

Section 2. Awards shall be made only on approval by the Board of Managers of a recommendation of a committee on awards.

The outgoing Board of Managers made this article operative on October 20, 1939, by the adoption of the Report of Committee on Awards and Memoirs, appointed March 6, 1939.

By this action the Board of Managers established awards for noteworthy discovery, accomplishments or publications in the biological, engineering, and physical sciences, respectively

The award will take the form of a suitably inscribed certificate. It will be limited to persons 40 or less years of age, who are members of the Academy, resident or nonresident, or to members of societies affiliated with the Academy resident in the Washington area.

The Board of Managers on January 12, 1940, approved the recommendations of the Subcommittees on Awards as follows·

Subcommittee on Awards representing the biological sciences recommended that a certificate of award be granted Herbert Friedmann, curator of birds, U. S. National Museum, for noteworthy research and publication in ornithology

Subcommittee on Awards representing the engineering sciences recommended that a certificate of award be conferred on Paul A. Smith, hydrographic and geodetic engineer, U S Coast and Geodetic Survey, for his contributions to our knowledge of the ocean bottom along the eastern coast of the United States

Subcommittee on Awards representing the physical sciences recommended that a certificate of award be given to Wilmot H. Bradley, senior geologist, U. S. Geological Survey, for his contributions to our knowledge of the oil shale of the Green River formation of Wyoming and of the Tertiary history of the adjoining Uinta Mountains (Utah)

These certificates will be appropriately presented at an early date.

The action of the Board of Managers regarding awards was approved by the Academy.

The tellers, Charlotte Elliott, Anna Jenkins, and Dorothy Nickerson, reported the election of the following officers: President, E. C. Crittendon; Nonresident Vice-presidents, P. G. Agnew and Gifford Pinchot; Corresponding Secretary, F. D. Rossini; Recording Secretary, F C. Kracek, Treasurer, H. S. Rappleye; Board of Managers, J. F. Couch and J. E. Graf.

All submitted amendments to the bylaws were approved.

In accordance with the report of the Tellers, the officers as submitted were declared duly elected by the President.

The Corresponding Secretary read the list of nominations for Vice-presidents submitted by the affiliated societies as follows:

Philosophical, R. E. Gibson
Anthropological, Frank M. Setzler
Biological, W. B. Bell
Chemical, A. T. McPherson
Entomological, A. H. Clark

National Geographic, A Wetmore
Geological, J. B. Mertie, Jr. (to be elected in March)
Medical, Fred O. Coe
Historical, Allen C. Clark
Botanical, Charles Thom
Archaeological, Aleš Hrdlička
Foresters, W. A. Dayton
Washington Engineers, P. E. Whitney
Electrical Engineers, H L. Curtis
Mechanical Engineers, Walter Ramberg
Helminthological, E W Price
Bacteriological, R. R. Spencer
Military Engineeers, C. L Garner
Radio Engineers, H. G. Dorsey

By vote of the Academy, the Recording Secretary was instructed to cast one ballot for the list as read. This was done and the Vice-presidents were declared duly elected.

As business from the floor, L. B. Tuckerman presented a petition to the Board of Managers for the revocation of the action doing away with the nonresident Vice-presidents of the Academy. This petition was signed by six members of the Academy and hence must be acted on by the Board of Managers at a future meeting.

President Chambliss appointed Past Presidents O. E Meinzer and W. J. Humphreys to escort President-elect Crittenden to the chair. After a short address President Crittenden declared the meeting adjourned at 10:30 p.m.

NEW MEMBERS ELECTED

The following have been elected to resident membership in the Academy:

Ida A. Bengtson, senior bacteriologist, National Institute of Health, in recognition of her contributions to bacteriology, especially work on anaerobic bacteria and rickettsia.

Miriam Lucile Bomhard, associate forest ecologist, U. S Forest Service, in recognition of her contributions to botanical knowledge, especially in the morphology and taxonomy of seeds of eastern plants, and to the ecology and taxonomy of palms, particularly the genera *Sabal*, *Butia*, and *Ceroxylon*.

Selwyn DeWitt Collins, principal statistician, National Institute of Health, in recognition of his contributions to statistical analysis pertaining to public-health problems.

Harold Raymond Curran, associate bacteriologist, U. S. Bureau of Dairy Industry, in recognition of his contributions to the science of milk bacteriology.

Lloyd Derr Felton, senior surgeon, U. S. Public Health Service, in recognition of his studies on pneumococcus and pneumonia

William N. Fenton, associate anthropologist, Bureau of American Ethnology, Smithsonian Institution, in recognition of his contributions on the ethnology of the Iroquois Indians

Edward Harrison Graham, biologist, U. S. Soil Conservation Service, in recognition of his contributions to botanical science, including flora of the Kartabo region, British Guiana, and botanical studies in the Uinta Basin of Utah and Colorado

Samuel Frederick Hildebrand, senior ichthyologist, U. S. Bureau of Fisheries, in recognition of his demonstration of the utility of fishes in mosquito control, his work on the life histories of marine fishes of the Atlantic coast, and his contributions to the ichthyology of Central America.

ROBERT SULLIVAN HOLLINGSHEAD, acting chief, Food Research Division, U. S. Bureau of Agricultural Chemistry and Engineering, in recognition of his studies on the use of the data of food analysis in the improvement of the technology of food handling and in the improvement of public health.

FLOYD ERVIN KURTZ, associate chemist, U. S. Bureau of Dairy Industry, in recognition of his contributions to the science of milk chemistry.

MORRIS ABEL RAINES, professor of botany, Howard University, in recognition of his researches in plant physiology

SYLVESTER T. SCHICKTANZ, senior chemist, U. S. Bureau of Internal Revenue, in recognition of his work on distillation and of methods for the separation of azeotropic mixtures.

LEONARD PETER SCHULTZ, curator, Division of Fishes, U. S National Museum, in recognition of his contributions to ichthyology, especially his studies of the fishes of the north Pacific.

CLARENCE R SHOEMAKER, assistant curator, Division of Marine Invertebrates, U. S. National Museum, in recognition of his special knowledge of Crustacea, especially the Amphipoda

EDGAR, REYNOLDS SMITH, senior chemist, National Bureau of Standards, in recognition of his contributions in the field of physical chemistry, especially for his work on "heavy water" and ebulliometry.

FRANK E. A. THONE, staff member, Science Service, in recognition of his contributions to plant ecology and his popularization of science.

RALPH P. TITTSLER, associate bacteriologist, U. S. Bureau of Dairy Industry, in recognition of his contributions to the science of bacteriology, especially in connection with *Escherichia coli* and *Escherichia-aerobacter*.

BYRON H. WEBB, dairy manufacturing specialist, U S. Bureau of Dairy Industry, in recognition of his contributions to the chemistry of dairy products.

FREEMAN ALBERT WEISS, senior pathologist, U S. Bureau of Plant Industry, in recognition of his work in plant pathology, especially on diseases of ornamentals, soil fungicides, and toxicity relations of fungi.

The following have been elected to nonresident membership in the Academy:

ERNEST BROWN BABCOCK, professor of genetics, University of California, Berkeley, Calif., in recognition of his contributions to knowledge of genetics and plant breeding, the nature and mechanism of germinal substance, taxonomy, and plant evolution.

CHARLES MARIUS BARBEAU, anthropologist and folk-lorist of Canada, Canadian National Museum, Ottawa, Ontario, Canada, in recognition of his many fundamental researches in ethnology, folk-lore, and folk-music.

OSCAR S ADAMS, *Recording Secretary*

Obituary

George Charlton Matson died in Tulsa, Okla., on January 3, 1940. He was born at Strang, Nebr., on February 4, 1873. He attended Doane College, where he obtained a B.S. degree in 1900, subsequently studied at the University of Nebraska and Cornell University, and in 1920 was awarded the degree of Doctory of Philosophy by the University of Chicago. He was an assistant in geology at Cornell University, 1901–03, instructor in geology at the University of Illinois, 1903–04, and fellow in geology at the University of Chicago, 1904–06. During the 10-year period 1906–16, he was an assistant geologist and a geologist with the United States Geological Survey. His scientific publications include reports on the ground-water resources, clay, and phosphate deposits of Florida, the late Tertiary and Quaternary formations of Mississippi, the oil and gas resources of Louisiana and the Coastal Plain of Texas, and other geologic subjects In 1916 he left the Geological Survey and joined the geological staff of the Mexican Gulf Oil Co Subsequently he was connected with the Gulf Refining Co of Louisiana, the Gypsy Oil Co., and the South American Gulf Oil Co From 1921 until his death he was a consulting oil geologist and from 1922 until 1929 he was also vice-president of the Schermerhorn Oil Co.

Dr. Matson was quiet and reserved in demeanor, an independent thinker, industrious and thorough in his investigations, and successful in his business undertakings His published writings are authoritative, and some of them were prophetic of important developments in oil and gas production in the Gulf region. He held membership in numerous scientific and technical societies, including the Geological Society of America, the American Association of Petroleum Geologists, the Geological Society of Washington, the Washington Academy of Sciences, and the American Society of Mining and Metallurgical Engineers In 1921 he served as president of the American Association of Petroleum Geologists

JOURNAL
OF THE
WASHINGTON ACADEMY OF SCIENCES

VOL. 30 MAY 15, 1940 No. 5

BOTANY.—*The botany and history of* Zizania aquatica *L.* (*"wild rice"*).[1] CHARLES E. CHAMBLISS, U. S. Bureau of Plant Industry.

For this evening I have assembled some of my field notes on *Zizania aquatica*, together with some historical data on the species, which I trust will meet the requirements of this occasion. And this is my story.

Life was easy for Wenibozho.[2] His indulgent grandmother, with whom he lived, demanded no work of him, and in consequence he passed through his early boyhood days without exhibiting any particular interest in those things that must be learned and thoroughly understood by people who depend largely upon self for the necessaries of life.

At last, the grandmother awoke to the fact that her grandson lacked the initiative so essential to meet the requirements of their race, and convinced that her solicitous care was responsible, the aging woman urged the indifferent youth to prepare himself with a training that would fit him to endure such hardships as hunger, thirst, and cold. She told him that experiences of this kind would make him resourceful and teach him how to care for himself and those who might be dependent upon him. Probably somewhat irked by these plain words, Wenibozho later said goodbye to his grandmother, who for many years had provided him with food and shelter.

Equipped with only a bow and some arrows, he started on a long journey through the forests. For meat, he had to depend upon the flesh of small animals. Not because there was a scarcity of animals, for they abounded in the woods, but because of his unskilled use of the bow, his kills were few. Therefore, he had to subsist on seeds, roots, and tubers. Without knowing the plants that could furnish nourishing food, he naturally made mistakes.

One day when thoroughly exhausted from want of food he heard a voice saying, "Sometimes they eat us." He heard this voice several times and finally asked, "To whom are you talking?" A small bush replied that it had spoken. As no part of the bush above the ground seemed edible, Wenibozho thought that the roots might be good to eat. He uncovered the roots, tasted them, and liked the flavor of them very much. Being hungry, he ate many of them and suffered from overeating. For several days he was unable to travel, and when he attempted to do so he found himself as hungry as before and quite weak. As he passed along seeking food, many plants spoke to him. Wenibozho gave no heed to their entreaties until he was attracted by the beauty of a graceful grass growing in a small lake basking in the sunshine of the open woodland. Some of these plants beckoned to him and said, "Sometimes they eat us." He was quite hungry now, and observing that the upper part of the plants was loaded with long seeds, he soon gathered some of them. Removing the hulls, he ate the kernels and found the taste of them so pleasing and their effect upon his hunger so gratifying that he exclaimed, "Oh, you are indeed good! What are you called?" The plants replied, "We are called manomin."

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[1] Address of the retiring president of the Washington Academy of Sciences, delivered on January 18, 1940. Received February 12, 1940.

[2] GILMORE, MELVIN R. *Prairie smoke*, pp. 195–198. 1929.

These adventures and discoveries of Wenibozho have served as a foundation for many legends that have been handed down through generations of Chippewa, Menomini, and related Indians. In their childhood, this story excited their imagination, and as they grew older they came to have veneration for this fruitful grass that provides such palatable and nourishing food.

Manomin,[3] an Algonquian word meaning "good berry," is suggestive and descriptive. By most of the tribes of this linguistic stock, this grass and its fruit are called manomin, and by the same name the plant became known to the early white settlers of the upper Mississippi Valley. Many common names for it came into use when the French and English population increased in this region. By the French it was *folle avoine*, a name most frequently found in the earlier accounts of that part of North America around the Great Lakes. The English names for the plant are quite numerous. Such names as wild rice, Indian rice, squaw rice, Canadian rice, black rice, Indian oats, blackbird oats, wild oats, and water oats are found in the literature. This plant, however, is not a species of rice or of an oat, though the vernacular names so designate it. Some of these names are only locally used. For example, this plant is known only by the name of water oats to the older inhabitants living along the tidal streams in the south Atlantic States.

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[3] JENKS, ALBERT ERNEST. *The wild rice gatherers of the Upper Lakes.* Ann. Rept Bur Amer. Ethnology, 1897–98, 19: 1024. 1900.

Among the adventurers who flocked to North America shortly after Columbus missed his way to India and discovered a new world, there was a sprinkling of naturalists who came to gather seeds and bulbs of plants that might be useful in the gardens, fields, and forests of Europe. Probably the most noted among them was Peter Kalm. Shortly after his return to Sweden he published in 1751 a small octavo pamphlet of 48 pages,[4] containing "a comprehensive summary of his observations on the habitat, use, and care of American plants which he considered of sufficient economic importance to warrant experimental introduction into Sweden." In the text Kalm says: "I have chosen this means to give an index and short account of some of the useful plants [a total of 126 species] the seeds of which I brought home with me from North America where I made a journey at the command of the Royal Academy of Science."

In reference to wild rice, which is included in this collection, he records: "In North America where the plant grows wild, it is used as food by all the savage nations, who yearly collect quantities. Wild ducks are particularly delicious when the rice is ripe, for at that time they live on it almost entirely. If we could succeed in getting this rice to grow and ripen here we would have gained a great deal, for the wettest places would become as productive as fields if the plant would stand our winters. Cattle are more than greedy for the leaves and stalks. The greatest difficulty will be to find a method of sowing seeds so they will germinate. We still know very little about nature's method of sowing the seeds of plants growing in water."

This attempt to introduce this wild plant into Europe was likely a failure, for Lambert, in a paper presented before the Linnaean Society of London in 1804, states that "the seed of [this species] *Zizania aquatica* in a vegetating state from America was long a desideratum among the botanists of this country; for although seeds were received here at different times, yet none of them grew. At last, Dr. Nooth by the desire of Sir Joseph Banks sent them from the lakes of Canada put up in jars of water. As soon as they arrived they were sown in a proper situation, where they came up in a few days and the plants ripened their seeds extremely well in the autumn." This importation of seed was made in 1791.

Resident collectors, among whom may be mentioned Bartram and Clayton, also aided in this work and in addition supplied the botan-

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[4] LARSEN, ESTHER LOUISE *Peter Kalm's short account of the natural position, use, and care of some plants, of which the seeds were recently brought home from North America for the service of those who take pleasure in experimenting with the cultivation of the same in our climate.* Agr Hist. 13: 34, 43–44 1939.

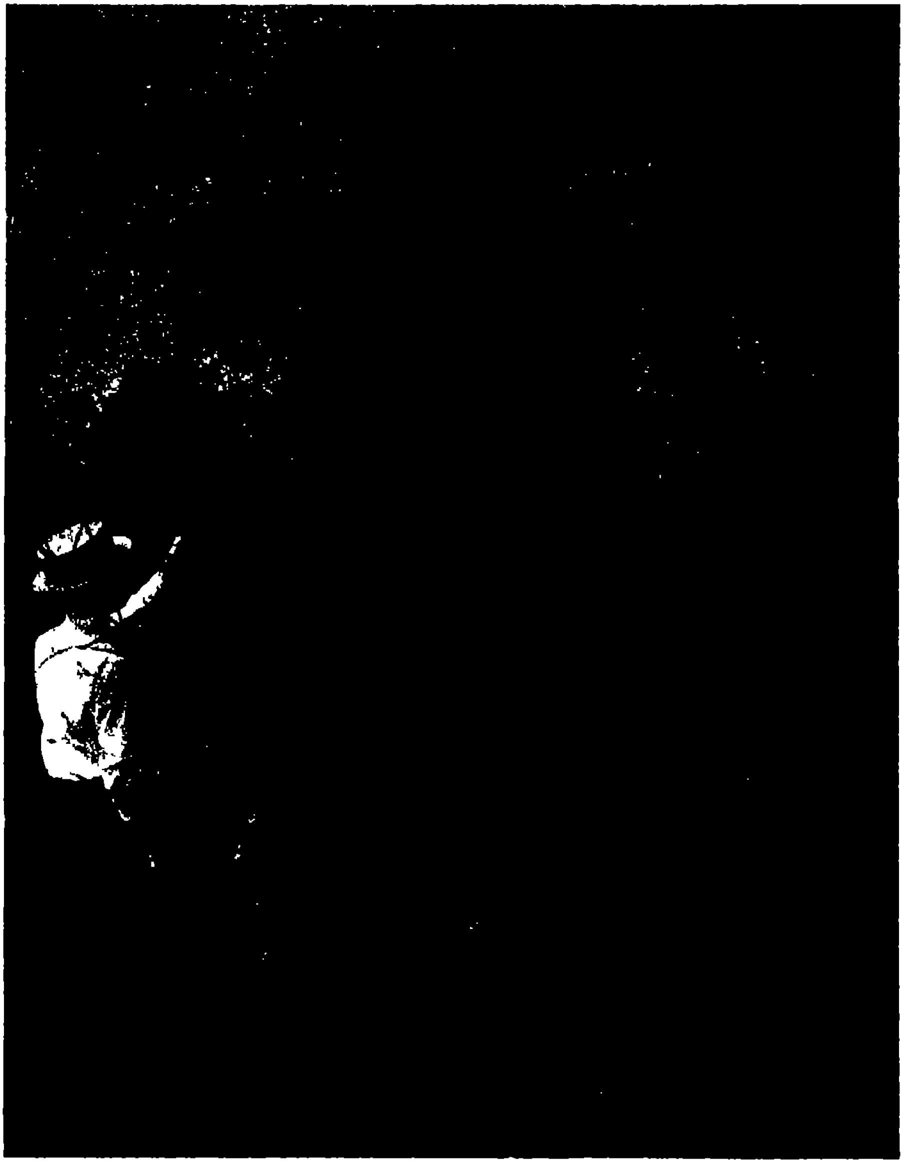

Fig 1.—Typical mature plants of the broadleaf *Zizania aquatica* growing in a Potomac River marsh.

ists of the continent with material that greatly enriched the herbaria of many botanical centers of the Old World. In this way a specimen of manomin, called wild rice by the white man, got to Europe, where in 1753 it was described and named *Zizania aquatica* by the Swedish

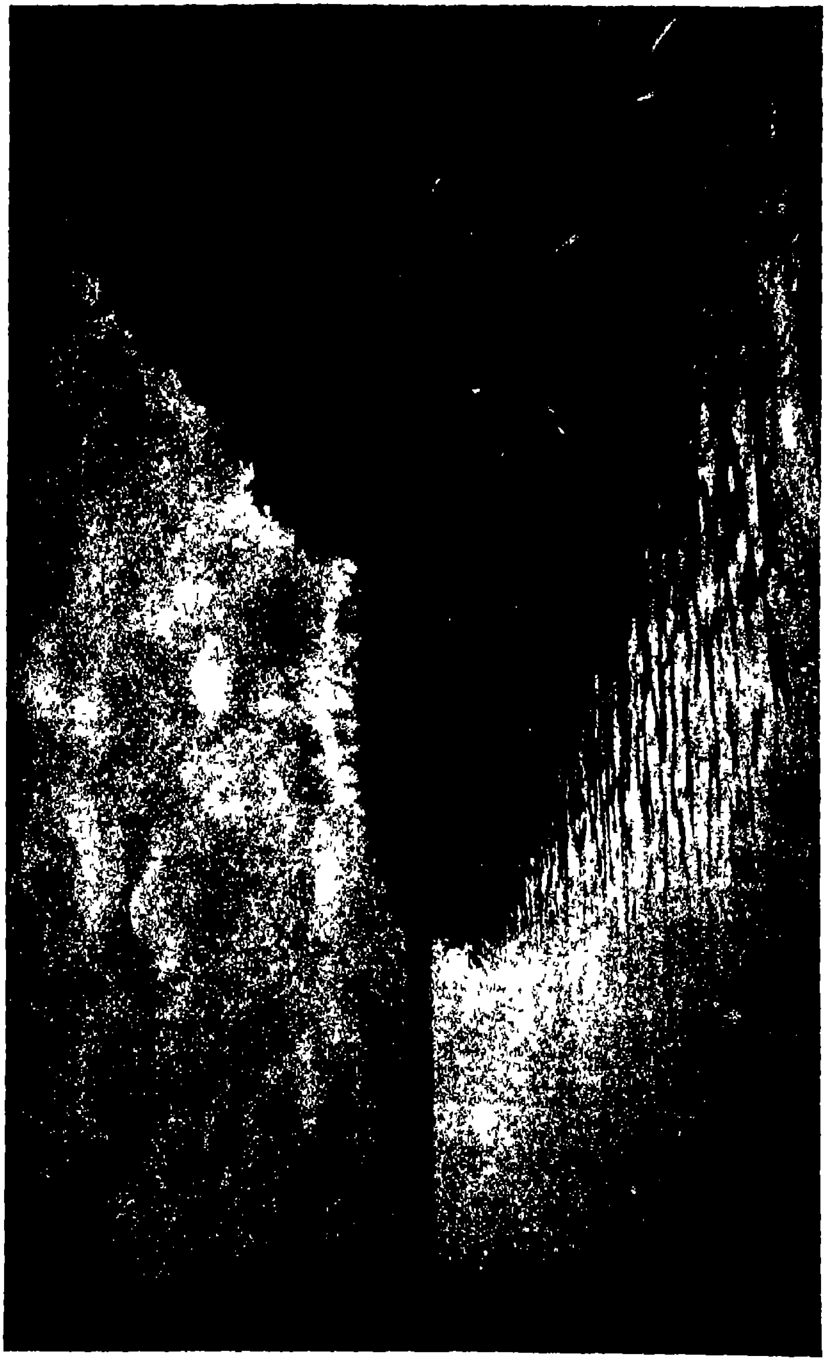

Fig. 2.—The broadleaf *Zizania aquatica* in flower in narrow marsh on east side of Theodore Roosevelt Island (Analostan Island), facing the Titanic Memorial, District of Columbia, August 20, 1935

botanist Linnaeus. Until then the "good berry" plant was unknown to botanists, although for centuries it had fed many tribes of wild men and for nearly 200 years had supplied the food wants of many European adventurers.

This grass, indigenous to North America, is found from Lake Winnipeg to the Gulf of Mexico and eastward from the Rocky Mountains to the Atlantic coast. Throughout these latitudes, and in this area where conditions are favorable, it is conspicuous among the aquatic plants growing in shallow lakes and in slow-moving streams. In the extreme northern and eastern limits of this region it often covers several hundred acres. Within its natural range the species often occupies the small bays of the large lakes, covers the mud flats on tidal rivers of the Atlantic Coastal Plain, fills the lakelike expansions of rivers near their source, and grows luxuriantly in the quiet bends of sluggish streams. It is seldom found in the inland lakes with no outlets. It grows well on a variety of soils under fresh-water streams and lakes. Its best growth, however, is made wherever the plants can anchor themselves in a thick layer of mud, regardless of the kind of soil.

Zizania aquatica is an aquatic, annual, self-sowing grass having tall, erect, cylindrical, and hollow stems, which bear the inflorescence and 4 to 6 long leaves with flat blades, conspicuously marked by a very thick midrib (Fig. 1). The slender stems have a comparatively thin wall, and when seen by transmitted light, thin, transverse partitions are revealed, dividing the internodal space into compartments, which give the stems a light banded appearance.

The stems vary in height from 5 to 10 feet and in diameter from one-fourth to five-eighths of an inch. The taller plants are characteristic of the tidal flats and the shorter plants of the northern lakes and streams. Plants with stalks as thick as 2 inches near the crown are not unusual in southern marshes. In thin stands and among isolated plants a single plant may have many stems, some arising from the base of the mother stem, though frequently as branches from the first and second nodes.

The principal roots are slender, fibrous, and numerous and do not penetrate deeply into the soil.

The first leaves to appear are long and narrow. In the later and permanent leaves the basal part known as the sheath is thick and spongy in structure and completely wraps the stem, thereby adding much to its rigidity. The sheaths vary in length from 9 to 25 inches.

The blade is the free end of the leaf. In the terminal leaves it may

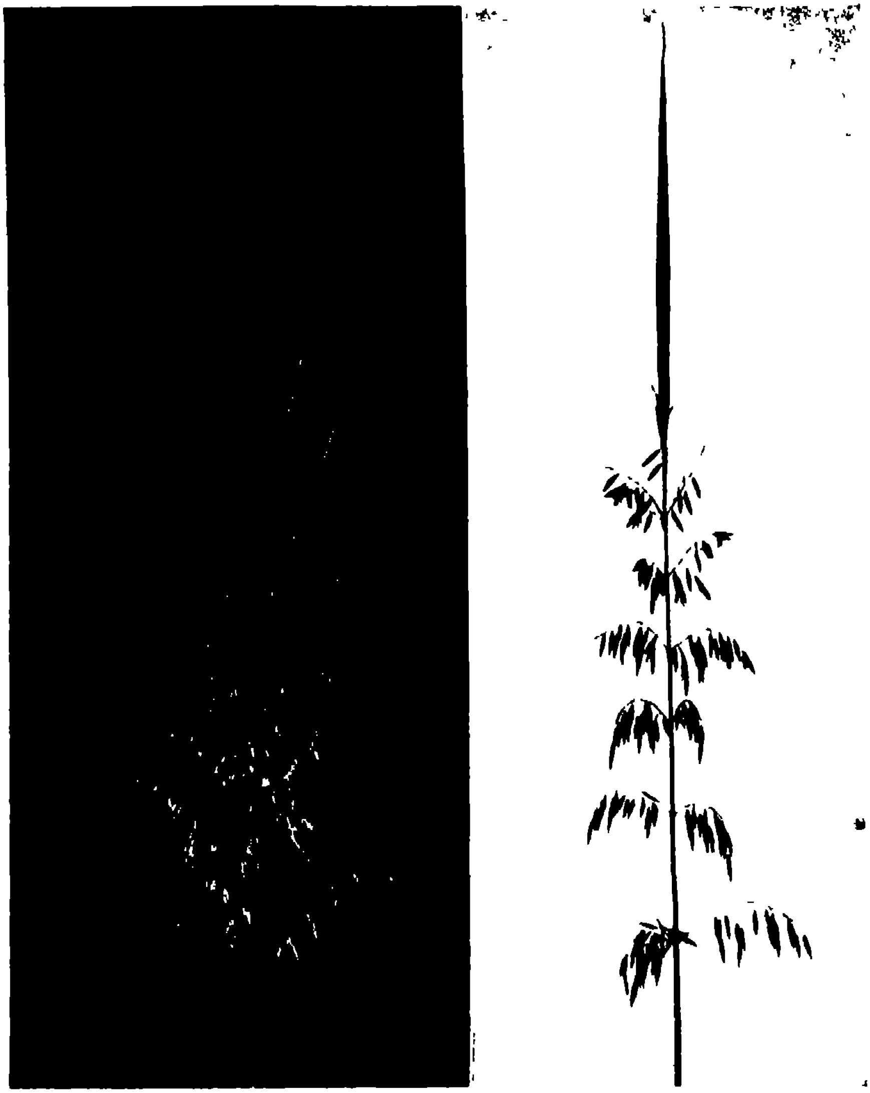

FIG. 3.—Panicles of *Zizania aquatica*. Left: Of the broadleaf form. Its natural length is 26 inches. Right: Of the narrowleaf form. Its natural length is 16½ inches.

be 2 to 4 feet long and from less than an inch to 1 inch or more wide.

The inflorescence (Fig. 3) is borne on the last node of the stem. It consists of two parts—an upper, with slender straight branches bearing the female or seed-producing flowers, and a lower, with drooping branches bearing the male flowers.

The female flower is very simple in structure, consisting of lemma

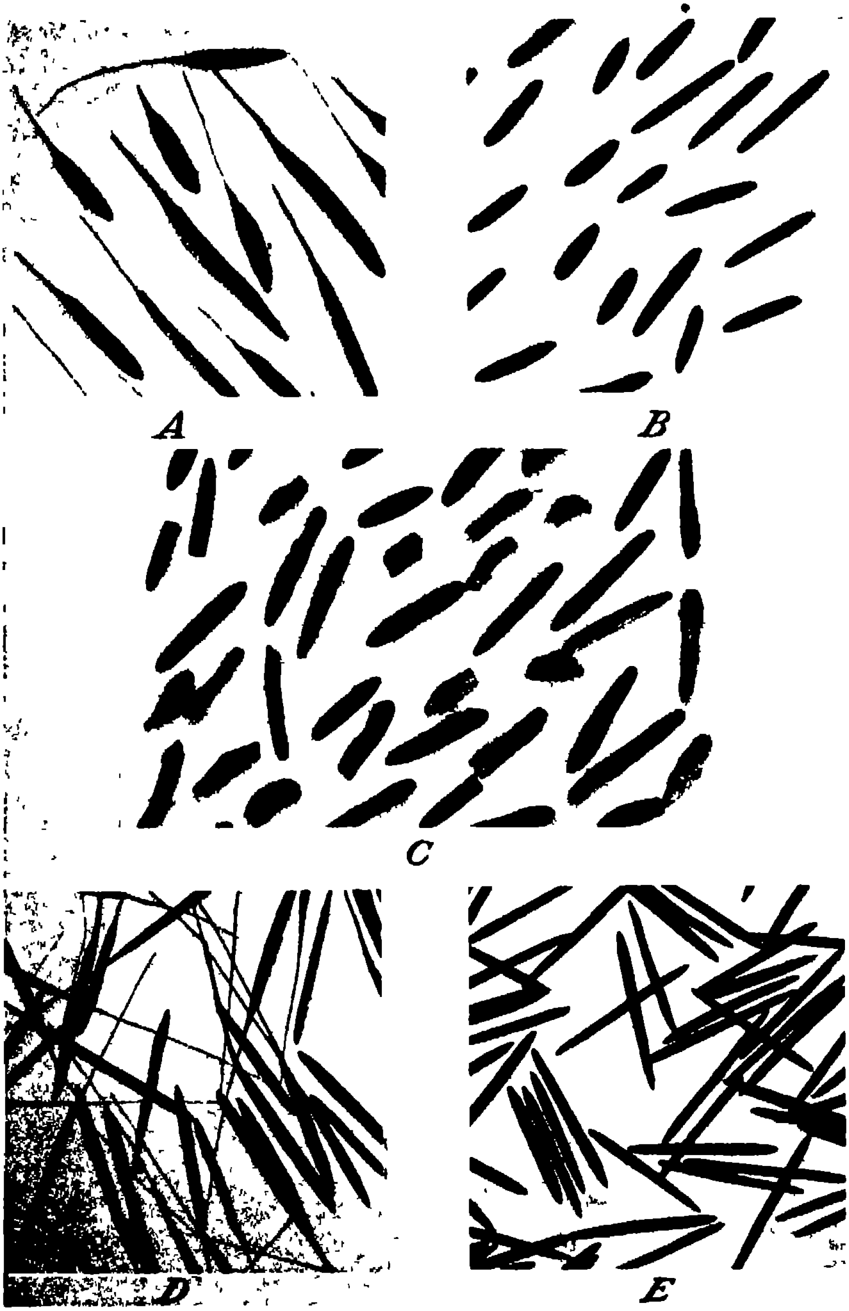

Fig. 4.—Seeds and kernels of *Zizania aquatica* (Natural size) Narrowleaf form *A*, seeds; *B*, kernels; *C*, parched kernels Broadleaf form. *D*, seeds, *E*, kernels.

and palea that enclose a much-branched stigma and a comparatively small ovary. The lemma bears a long awn or beard. In the male flower, there are also a lemma and palea, which are much shorter than in the female flower. They enclose six bright yellow stamens.

The seed is long and slender and almost cylindrical (Fig. 4, *A*, *D*). A thin brown hull made up of the lemma and palea encloses the kernel and bears a long, stiff, straight awn that is covered with numerous barbs or bristly hairs. The surface of the hull itself is covered with similar hairs.

The kernel of the southern plants averages 20 mm in length and 1.4 mm in width (Fig. 4, *E*). In the northern plants the kernel has an average length of 12 mm and a width of 2 mm (Fig. 4, *B*). There is a shallow groove on the ventral surface of the kernel in which a long embryo is concealed. When fully matured the kernel is purplish black in color.

Zizania aquatica has two rather distinct forms, and within each there are many variants. The form having broad leaves and long needlelike kernels grows along the tidal rivers emptying into the Atlantic Ocean and is also found locally in the interior as far north as southern Minnesota and Wisconsin. The form with narrow leaves and short thick kernels grows in the upper Mississippi Valley and eastward along the Canadian border.

In ascending a tidal stream such as the Potomac River, which is salty or brackish almost to the head of tidal water, the halophytic vegetation begins to disappear with the appearance of *Scirpus americanus*, a fresh-water rush quite resistant to brackish conditions. As the conditions become less saline, fresh-water plants begin to occupy the marshes, and principal among them is *Zizania aquatica.* If the *Zizania* marsh slopes gradually into a slow-running stream, several distinct zones of plants will be present. The deeper water will be inhabited by several species of *Potamogeton*, *Vallisneria spiralis*, and such free-swimming plants as *Lemna* and other duckweeds. In water less than 5 feet in depth, the yellow pond lily may occur.

The next zone is usually narrow and is populated with the pickerel weed *Pontederia cordata*, which grows in approximately 2 feet of water. Having a very large root system it is capable of holding its place in a moderate current and serves as a protection to the adjoining zone containing *Zizania aquatica*, the plants of which are not strongly anchored in the soil. Although such a marsh is inundated, the depth of water covering it varies with the condition of the tides.

The *Zizania* zone is broad and usually parallels the stream for some distance (Fig. 2). The luxuriant growth of *Zizania aquatica* shades out most of its competitors, leaving it in possession of the land except where the stand is thin on the margin of the stream. Here straggling plants of *Polygonum sagittatum* and species of *Sagittaria* and *Bidens* are sometimes present. On the land side of this zone the dominant species is *Typha latifolia*, which under conditions of less water and greater silt deposit may displace *Zizania aquatica*. The *Typha* area itself is soon invaded by *Peltandra virginica*, *Iris versicolor*, and several species of *Hibiscus* and *Polygonum*. As the marsh becomes more elevated and drier, shrubs and finally trees become dominant.

In the lakes of Minnesota and Wisconsin, just beyond the zone containing such submerged plants as the *Potamogeton* species and *Vallisneria spiralis*, the bottom is often thickly covered with plants having lime-encrusted leaves and stems called stoneworts. The *Zizania* area is usually bordered on the outside margin by several species of *Scirpus*, never by *Pontederia cordata* as along the Potomac River, and on the land side by *Carex*, though *Typha* is often present.

During early April in the vicinity of Washington, D. C., the seedlings of *Zizania aquatica* have already emerged from the muck-covered flats and are strong enough to stand erect when the tide is out, like seedlings in any grainfield. Within a week or 10 days after emergence the young plants have three leaves. Growth is slow at first largely because of the low temperature of soil and water and intermittent sunshine. During these days they are strengthening their grip upon Mother Earth, for good anchorage in the soil at this time reduces the hazard of being washed away by tides, especially the ebb flow. The protection of the marginal plants that they have in later life is lacking now. The plants become more robust as spring advances, and by June, where the stand is good, the growth gives the marsh the appearance of a low meadow. In another month the stems that have been concealed by the enveloping leaf sheaths during this vegetative growth begin to give some evidence of their existence.

The part of the stem embraced by the sheath of the last leaf is growing rapidly now and being confined within a narrow space distends the sheath into a spindlelike appearance. Ten days after the inception of this condition is perceptible, the panicle, which is the terminal of the stem, begins to emerge. The panicle emerges slowly, often requiring seven days to free itself from this cover. It carries on its distal end the female flowers that bloom almost immediately upon emergence. They, at once, are receptive to wind-borne pollen from nearby or distant plants, for the male flowers of the same plant are still within the leaf sheath.

The male flowers on the lower part of the panicle hang like elongated purple bells, which open a few days later, revealing six yellow bodies like so many clappers, which are filled with pollen that is soon discharged into the air to be carried by the wind to other plants. This pollen takes no part in the fertilization of the female flowers of the same flower cluster. The male flowers on long drooping branches arranged in whorls add beauty and symmetry to this tall, slender, stately plant attractively dressed with long, broad, hanging leaves.

The slender, flexible panicle, when fully protruded, may be 30 to 50 inches above the terminal leaf. On its topmost branches the seeds are developing very irregularly. As they approach maturity, which normally occurs within 15 days after fertilization, the seeds drop very readily, passing quickly through the water to the mud bottom below. They do not float and are soon anchored in a soft bed by the many bristlelike hairs on their outer surface. These structures, by their number and arrangement, serve to fasten the seeds more securely in the mud. Here they lie until the following spring, when the majority of them germinate.

Zizania seed can not be kept in dry storage like other seed. To retain its viability it must be kept in a wet state and at a temperature that will prevent fermentation and control germination. There is no harvesting of this seed in Eastern United States for human use. Many birds, however, feast upon it and in so doing assist in the natural sowing of enough seed to provide for next season's crop. The dense brown mat of fallen plants and crumpled foliage, which soon covers the marsh, will again look green in spring when the young plants, sprouting from this self-sown seed, push their way through and above this organic debris.

The birds that feed upon this maturing grain are the bobolinks and red-winged blackbirds. Late in August and early in September these birds may be seen in large flocks settling on the plants of *Zizania aquatica* at meal time, which continues throughout the day. The wading birds, such as the sora, feed upon the fallen seeds that lie in shallow water, or exposed on the ground, when the tide is out. Many species of diving ducks feed upon the seed that has settled in the mud.

The center of the largest area of this uncultivated grain is in the region of the adjacent sections of Minnesota, Wisconsin, Manitoba, and Ontario, which is crowded with alluvial bottom lakes, serving as sources of many rivers that for great distances meander through a flat country and give the landscape the appearance of one immense marsh. The Fox River, on which the earlier explorers traveled from the Great Lakes region to the Mississippi River, may be taken as typical of such streams, filled for the greater part of its length with *Zizania*. The Indians[6] tell us that this river was made by a monstrous serpent that spent the night in the marshes between Lake Winnebago and the Wisconsin River. Having obtained during the day enough food to satisfy its hunger, this creature at dusk crawled in among the vegetation covering this low land to sleep off the lethargy that accompanies a full meal. While it slept, the dew accumulated upon its body. At sunrise it awoke and shook the moisture from its back and in it wriggled toward the larger lake, leaving behind a chain of small lakes that now are expansions of the river that became the waterway to the great Northwest. In his account of ascending this river in 1673, Marquette says, "The way is so cut up by marshes and little lakes (Fig. 5) that it is easy to go astray, especially as the river is so covered with wild oats [*Zizania aquatica*] that you can hardly discover the channel. Hence, we had good need of our two guides."

In many places throughout this region such conditions exist today, in normal seasons, from the middle of June until the first of October. When the waters are free of ice, usually about the middle of May, *Zizania* seed begins to germinate. Most of it was sown by nature early in autumn of the preceding year and some of it through accident by the Indians themselves in spite of their skill in harvesting the crop.

The seedlings grow very slowly at first, too weak to stand erect without the support of the water, which not only surrounds but covers them, often deeply. During this early growth, with their narrow leaves floating and reaching upward and outward, the plants appear, when seen from a canoe floating over an old *Zizania* bed, like so many hydrae seeking their prey. In less than a month the young plants push their leaves to the water surface, spreading them upon it in long streamers, which at a distance upon good light conditions give the lake the appearance of having a low verdant island. In approaching small beds of this plant, the emerging leaves could be taken, even at a short distance, for a thick growth of duckweeds. In this stage of growth, the plants are greatly exposed to wave action. By it they may be detached from the soil and brought to the surface of lake or stream, leaving only open water where a few days before the young

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[6] THWAITES, REUBEN GOLD *Historic waterways*, p 153 1888

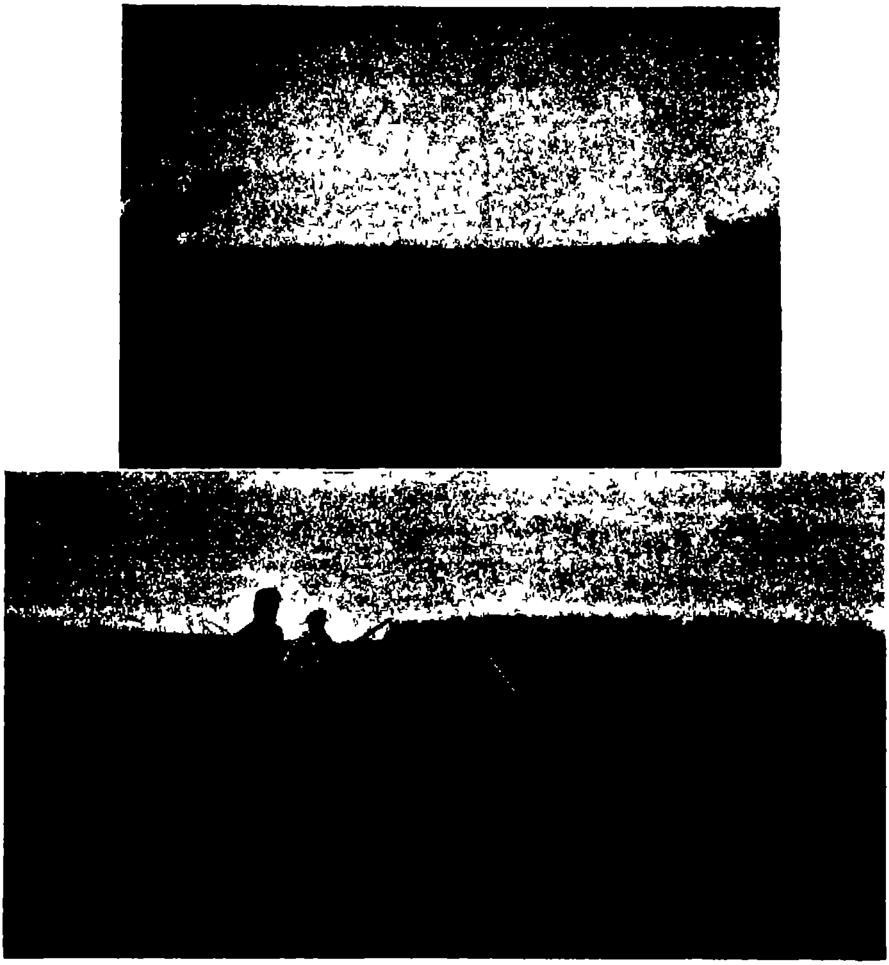

Fig. 5.—Upper: A small lake in northern Minnesota filled with *Zizania aquatica* ("wild rice"). It has the appearance of a low meadow. August 1938. Lower: Young Chippewa Indians, in boats, have just finished harvesting "wild rice" in a Minnesota lake. The plants are still erect and there is no open water to be seen. September 1938.

plants gave the area the appearance of a green field. Entire stands covering a hundred acres or more are often destroyed in this way. When water and weather conditions are favorable, the plants are strong enough in July to push their stems upward. A few weeks later the flower clusters begin to emerge. The stems are stronger now and have become more erect. Continuous sunshine and a mild temperature ripen the seed in about three weeks.

Among the Indians about this time the topic of conversation is "ricing," a word coined by the white man and used only in reference to harvesting this grain. The urge to assemble at their favorite lakes begins now to grow upon these people. They drift in singly and in family groups, settling usually in a wooded spot overlooking the ricebeds. In a few days a camp of many families is established. The Indians' information on the crop is rather definite, for during the season the rice-producing lakes are frequently scanned by them to ascertain the stand, vigor of plants, and probable seed production. Besides their interest in the crop as a source of food and revenue, this harvest time is the great social event of the year. Within these camps life presents a picture that is quite primitive even though here and there are evidences of contact with the white man's world.

When it becomes known after an inspection that about one-fourth of the seeds appear ripe, the men and women and the older boys and girls take to boats (Fig. 5).

The grain is harvested from canoes that may or may not be the handiwork of Indians. Narrow flat-bottom boats, made of planks and pointed at each end, are also used. These are made by the Indians and are as expertly handled by them as the canoes. Either type of craft is preferred to broad-bottom boats. The latter kind, because of difficulty in handling, destroys many plants and shatters much grain that would be gathered from a boat more easily handled. In using the narrow boats the gatherers may return to the crop as the seed ripens and this may be done two or three times. With the broad-bottom boats, which are used by the white men, only one passage over the ricebeds is ever made.

Our cultivated grain ripens rather uniformly, but not so with this wild plant. The harvest in a certain locality may extend over a period of two to three weeks when weather conditions are favorable and when the crop is in the hands of Indians. The white man who gathers this grain is not a conservationist. By heritage the Indian is.

Each craft is occupied by two persons, one who stands in the stern, using a long forked pole to push and guide the boat slowly among the plants, and the other usually a squaw, who gathers the grain, seated near the middle of the boat, facing the bow. With two small pointed sticks, about 30 inches long, one in each hand, the seated person runs one of the sticks into the plant growth, bending a few plants over the boat, and strikes the grain-bearing part of the panicles with the other stick quickly and lightly. The grain, which is easily dislodged, drops upon the covered bottom of the boat or canoe. This performance is repeated on the other side of the boat and continued alternately

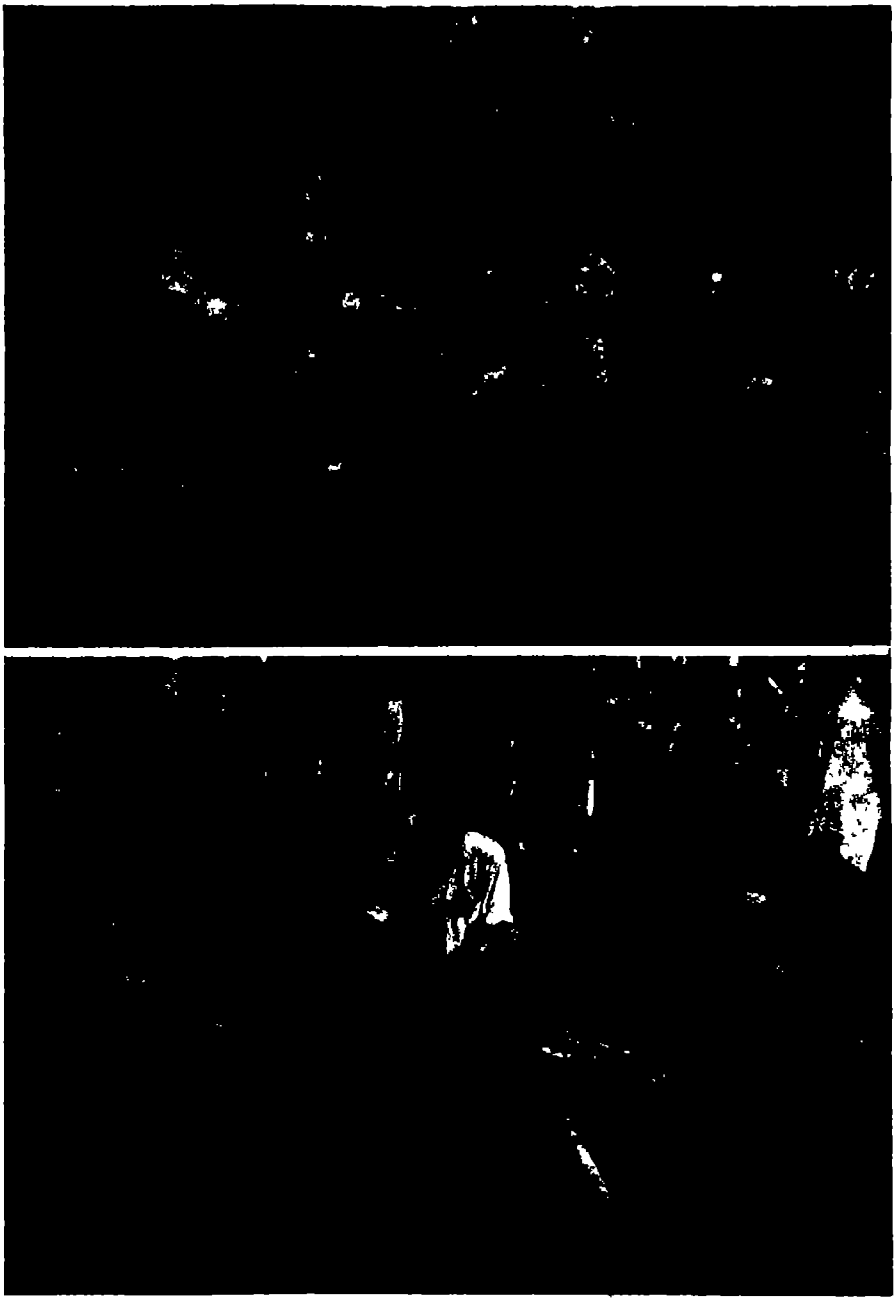

Fig. 6.—Upper: A Chippewa woman parching "wild rice" in a typical Indian camp, northern Minnesota. September 1923. Lower: A Chippewa Indian hulling ("jigging") parched "wild rice" in a typical Indian camp, northern Minnesota. September 1923.

while the boat is moving until 75 to 100 pounds of seeds have been gathered.

The harvested grain can not be kept perfectly dry while in the boat. The added moisture is usually driven off by thoroughly airing the grain, spread out in the sun on skins, birch bark, blankets, or canvas. After the grain is dried in this manner for several days, though sometimes this step is omitted, it is put into a large iron kettle or a galvanized iron tub, about 25 pounds at a time, and parched slowly over a wood fire, being constantly stirred with a paddle to prevent burning (Fig. 6). Parching requires from 15 to 25 minutes, depending upon which of the above containers is used. The grain parched in the iron kettle requires more time for this process and usually is a better quality than that parched in a tub, probably owing to the fact that a uniform heat is more easily maintained in the former than in the latter.

The grain is now ready for the most primitive kind of a mill. This equipment, which may be termed a mortar, is a hole in the ground about 1½ feet wide and 2 feet deep and lined with a skin. When ready to operate, about 20 pounds of the parched grain is poured into this receptacle. A buck Indian (Fig. 6), taking the part of a pestle, steps upon this loose pile of grain and with a half jump on one foot and then on the other, combined with a kind of shuffle, treads out the kernels. While supplying this power the Indian supports himself by poles driven into the ground near the hole. This process, usually called "jigging," detaches the hulls and completes the milling.

The mixture of kernels and hulls taken from the skin-lined hole is now put into a birch-bark tray, about 30 inches long, 20 inches wide, and 6 inches deep, to be separated by means of the wind. A windy day is usually used for this purpose, yet in the hands of a skillful squaw the tray without the aid of wind becomes a very efficient fanning mill. The operator, while standing, holds the partially filled tray even with her waist and slightly inclined. At regular intervals she tosses the contents of the tray. After each toss, the kernels tend to fall toward the lower side of the tray and the hulls toward the upper side. After this partial separation the mixture is tossed higher into the air, and at the same time with a quick movement of the wrists the tray is turned forward, producing enough wind to throw much of the chaff several feet away. This operation is repeated until the chaff is completely removed. If the grain was fully matured when gathered and the hulls loosened and detached by parching and "jigging," this primitive method of cleaning leaves only the heavy kernels, which, after washing in several changes of water, are ready for cooking (Fig. 4, *C*).

Some new methods of preparing the grain, brought about through intercourse with the white man, are gradually being used by the Indians. The primitive method of parching and hulling, however, although it does take time and labor, produces a product superior in quality to that so far obtained by the white man. The use of modern machinery for cleaning in place of the birch-bark tray could be used to advantage and is now being considered by dealers who are seeking larger markets for this cereal.

The Indians known as wild-rice gatherers belong to the two great linguistic stocks,[6] the Algonquian and the Siouan. The former includes the Chippewa, Menomini, Cree, Fox, and other small tribes. Among the latter the principal tribes are the Sioux, Winnebago, and Assiniboin. Probably the Menomini and Winnebago were the first important tribes to enter the eastern border of the great wild-rice country, for when found by Nicollet in 1634 they were well established in the vicinity of Green Bay, an area now within the State of Wisconsin. They had migrated from the Atlantic seaboard.

According to Indian tradition the Menomini tribe has been identified with wild rice for remote ages. Their name is usually translated to mean "wild-rice people." It has been their belief that "whenever the Menomini enter a region the wild rice spreads ahead, whenever they leave it the wild rice passes."[7] In their economy agriculture had a very minor place. They lived almost exclusively on game and on plants requiring no cultivation. They put a high valuation on wild rice and considered it a gift from the spirit powers, and therefore it has always been an essential basis for their ceremonial feasts and offerings.

In 1852 the Federal Government assigned to this tribe a large timber tract on the upper Wolf River as a permanent reservation. Here they are today, no longer "wild rice people" but foresters engaged in lumbering, having a tribally owned mill at Neopit that has been in operation since 1908. Within their reservation there are a few wild-rice patches, but they receive no attention because they are too small to produce a worth-while crop. Although the Menomini do not gather wild rice today, they still use it ceremonially.

The Winnebago Indians were less nomadic than the other Siouan tribes and lived near the waterways in preference to a life on the plains, which the Sioux enjoyed so much. For food they, like the

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[6] JENKS, ALBERT ERNEST Op cit, p 1038.

[7] KEESING, FELIX M. *The Menomini Indians of Wisconsin* Mem Amer Phil. Soc. 10: xi+261. 1939.

Menomini, depended upon fish, small mammals, wild rice, maple sugar, and berries.

When the Chippewa, one of the largest tribes north of Mexico, began to move westward, they were driven forward by the Iroquois, who occupied land that was not overstocked with game but well suited for cultivation. These newcomers, being hunters, were not welcome by the tillers of the soil and were forced by circumstances to continue westward. As the Chippewa moved onward, they encountered the eastern bands of the Sioux tribe occupying the lake region now a part of Wisconsin and Minnesota.

This part of the great central valley of this continent is filled with innumerable shallow lakes and sluggish streams that at one time contained an unfailing supply of food. To the red man centuries ago this region was a hunter's paradise. Besides wild rice and fishes and other water-inhabiting animals, it contained for the aborigines an inexhaustible supply of land animals too, the flesh and hides of which provided food and clothing. These natural resources were considered by the Sioux who first possessed them and by the Chippewa who desired them as tribal property of the greatest value, and each fought fiercely to get control of them. To these gifts of Nature should be added the beautiful and useful birch, the bark of which the original inhabitants and their descendants have used to cover their lodges, wigwams, and canoes. The bark of the basswood, too, has contributed much to the wants of these people.

Without a decisive engagement at any time, the struggle between these tribes for the full possession of this country continued at intervals for several centuries until 1862, when the Government removed the Sioux.

The Chippewa never had an undisputed control of these lakes, though for several hundred years they ventured upon them to gather wild rice, often at the cost of a heavy loss of life. The Indian who gathers wild rice in the United States today is of this tribe. His appraisal of these lakes and woodlands made centuries ago has not changed with the years. So, on many occasions, when new treaties had to be made to gratify the greed of the white man, the Chippewa Indians have asked our Government to give heed to their needs.

As late as 1863, Hole-in-the-Day, the leading chief of the Chippewa, addressed a pathetic appeal to the Great Father at Washington, which, in part, is as follows:[8]

[8] Report of the Commissioner of Indian Affairs for the year 1863, pp. 328–331.

> My people are unhappy and dissatisfied. I want to see them happy and contented. It is both to their interest and the interest of the white man that they should be so, and they require but little to make them so. * * *
>
> The present treaty gives us little but swamps or marshes, where locations can be selected that combine all these elements of comfort and content to our people, that is, good land, game, fish, rice and sugar. Here, we have neither to any considerable extent. True, we may find a little rice and a few fish, but not sufficient for my people, not enough to save them from starvation. If a treaty were made with the Red Lake Indians, a tract of country of the best character for my people might be secured without any outlay of expense to the government: say that strip of land lying on the Wild Rice River between the 47° and 48° north latitude and east of the Red River. There is every advantage of good soil, game, fish, rice, sugar, cranberries and a healthy climate. * * *
>
> This late treaty never will, never can satisfy our people. A reservation on the Wild Rice would satisfy them all, and they would leave their present homes and go to their new ones happily and with a feeling that a better future was before them. * * *
>
> The sooner this is done the better, as it would have a tendency to quiet the discontent now existing among our people generally, by holding out to them a prospect of a good and pleasant home somewhere near or in the valley of the Wild Rice. * * *
>
> Believe me, then, my Father, to be what my people always have been and what they and I now am, Your friend and the friend of the white man.

Wild rice has played an important part in providing subsistence to explorers and trappers who penetrated this great continent two or three centuries ago along the waterways that now separate the United States from the Dominion of Canada.

A traveler among the North American Indians during the years 1652 to 1684, after referring to his reception by the natives, states, "Our songs being finished we began our teeth to worke. We had there a kinde of rice, much like oats. It growes in the watter in 3 or 4 foote deepe." After comments on God's care over His creatures and a brief description of how the grain is gathered, he continues: "That is their food for the most part of the winter and doe dresse it thus: ffor each man a handfull of that they putt in the pott, that swells so much that it can suffice a man."[9]

In his *Travels and adventures in Canada and the Indian Territories*, Alexander Henry[10] tells us a hundred years later about obtaining from Indian women by barter 100 bags of this grain and adds that "without a large quantity of rice the voyage could not have been prosecuted to its completion."

[9] *Voyages of Peter Esprit Radisson.* Transcribed from original manuscripts in the Bodleian Library and the British Museum The Prince Society, Boston, 1885

[10] HENRY, ALEXANDER. *Travels and adventures in Canada and the Indian Territories, 1760–1776*, new ed, p. 241. 1901.

An ample supply of wild rice was always included among the winter provisions for the outposts of the fur companies trading in this region. David Thompson[11] records in his *Narrative of explorations in western America* that a superintendent of a fur company in northern Minnesota and his men "passed the whole winter on wild rice and maple sugar." Under such circumstances he considered this grain "a weak food" and says that "those who live for months on it enjoy good health and are moderately active but very poor in flesh."

The old journals of the earlier hunters, trappers, and priests seeking adventure in this great wilderness of the north contain many stories about the use of this grain in fighting hunger when other food was hard to get. In the great outdoors, white men, like Indians, can retain health, develop endurance, and enjoy life on a very simple diet.

The aborigines of this country were fond of soups, broths, and stews thickened with wild rice.[12] To this day, their descendants have not lost that fondness. In addition to its simplicity, this dish has the character of elasticity, which appeals to the Indians. With them mealtime is often visiting time. A meal started with three people may be increased to ten or more before it is finished. The uninvited guests never seem to cause embarrassment. To provide for them it is necessary only to add water to increase the volume of the soup.

With a squaw as a cook a favorite dish in the camp of rice-gathering Indians has been wild rice, corn, and fish boiled together, called "Tassimanonny."[13] This combination of foods has also tickled the palate of the white man, as may be judged by the enthusiasm of one who spoke of it in his later years as being "an object of early love." The Indian likes sweets and often eats his boiled rice with maple sugar.[14] He may also flavor his boiled rice with cranberries and his soup with blueberries. Boiling does not, as a rule, reduce the kernels to a paste, but should this condition occur, the pastelike mass is used by the Indians as a substitute for bread.[15]

Some Indians parch wild rice until the kernels burst open as popcorn does when heated, and eat it in this condition when away from camp.[15] Because of its keeping qualities, the parched grain is recommended to vacation campers for use in either the dry or boiled state. In the land of "Ten Thousand Lakes" where the parched grain is comparatively cheap and is usually a part of the daily meal, the woodman has the advantage of the man of the city, who must pay exorbitant prices for it to cover handling charges and profits. Under these circumstances wild rice in the city home is seldom used except on special occasions.

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[11] THOMPSON, DAVID *Narrative of explorations in western America, 1784–1812.* The Champlain Society, Toronto 1916

[12] SMITH, HURON H *Ethnobotany of the Meskwaki Indians* Bull Publ. Mus City of Milwaukee 4: 259 1928

[13] BIDDLE, JAMES W *Recollections of Green Bay in 1816–1817* Appendix No 4 First Ann Rept. and Collections of the State Hist Soc of Wisconsin for the year 1854, 1: 63.

[14] DUNBAR, SIR GEORGE *Other men's lives,* p 149 1938

[15] STICKNEY, GARDNER P. *Indian use of wild rice* Amer Anthrop. 9: 115–121. 1896.

Knowing how some like the grain, we may assume that all would be just as enthusiastic "ffor each man a handfull of that they putt in the pott" and would exclaim with Wenibozho, "Oh, you are indeed good!"

PALEONTOLOGY.—Paralbula, *a new fossil fish based on dental plates from the Eocene and Miocene of Maryland.*[1] S. F. BLAKE, Washington, D. C.

In the fall of 1935, my wife, Doris H. Blake, found a nearly perfect specimen of the crushing dentition of some fish on the shore of the Potomac River at Liverpool Point, Charles County, Md. The deposits exposed in the bank at this place belong to the Piscataway member of the Aquia formation (Lower Eocene), and the specimen, although not found in situ, can be attributed to this period with as much confidence as the teeth of *Lamna obliqua* and other sharks found in abundance on the Potomac shore at the same locality. The specimen was given to the U. S. National Museum and has since been recorded and figured by Dr. George S. Myers.[2] Dr. Myers identified the specimen as one of the Albulidae (ladyfishes), which he regarded as including among living forms only two monotypic genera, but he refrained from giving a name to the specimen or even assigning it to a genus because the crushing tooth plates of the two existing genera are not distinguishable.

The nearly perfect condition of this specimen and the fact that it was the first fossil representative of the Albulidae to be recorded from America, with the exception of a scale from the Cretaceous of Florida described as *Albula antiqua* Cockerell,[3] seemed to make it desirable to assign a specific name to it, if only to prevent it from being overlooked. Examination of the pertinent literature and of alcoholic specimens of *Albula vulpes* kindly made available by Dr. L. P. Schultz soon showed that this dental plate could not be referred to either of

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[1] Received January 12, 1940

[2] MYERS, G. S. *A third record of the albulid fish* Dixonina nemoptera *Fowler, with notes on an albulid from the Eocene of Maryland.* Copeia 1936(2): 83–85, fig. 1. 1936

[3] Copeia 1933: 226. 1933.

the recognized existing genera of the Albulidae. In *Albula*, the best-known representative of the family, the lower dental plate is twice as long as wide, or more, and bears only a single layer of teeth, which on dropping out leave a circular rounded-out pit in the surface of the supporting bone. This description applies to the fossil species, two of which are described from the Eocene of England, and one from that of Nigeria, as well as to the living one. The Maryland fossil is much wider in proportion to its length, and its teeth are superposed in irregular piles of 4 to 6, or probably more in the center of the plate, and on breaking or wearing they do not leave a cavity but are replaced from beneath, as in *Phyllodus* and some other genera of fossil fishes. The teeth, moreover, as shown in the accompanying sketches, are quite different in structure from those of *Albula*.

In superficial appearance the plate in question is very similar to the original illustrations of *Egertonia*, a genus described by Cocchi from the Eocene of England. Errol I. White, of the British Museum, to whom an enlarged photograph was sent for comparison with the type of *Egertonia*, reported that the latter is very different, the teeth resembling those of the related *Phyllodus*, being very thin, usually only slightly convex, with very numerous successors in piles, while both upper and lower plates are sigmoid in profile. Mr. White regards the Maryland specimen as representing an apparently undescribed genus, which may bear somewhat the same relationship to the albulids that *Labrodon* does to the labroids and *Diaphyodus* to the sciaenids—that is, a fossil form with pharyngeal dental plates similar in general to those of living forms, but having each tooth subtended by a pile of successional teeth. Its assignment to the Albulidae, however, must be regarded as only tentative.

Paralbula Blake, gen. nov.

Pharyngeal dentition similar to that of *Albula*, but each tooth with a pile of subvertically arranged successors.

Type species, *P. marylandica*, n. sp.

Paralbula marylandica Blake, sp. nov.

A nearly oval lower pharyngeal dental plate measuring 35 mm in length, 26 mm in width, and 11 mm in depth, broadly rounded at anterior end, subtruncate behind, convex-rounded on the oral surface, somewhat flattened along midline especially posteriorly, slightly concave on the attached surface. Triturating surface densely covered with jet-black, shining, subcircular, depressed-hemispherical teeth, about 141 in all (including bases of broken-off teeth), not arranged in definite lines, the central ones 3.2–3.5 mm in diameter, the lateral gradually decreasing in size, the outermost 2–2.5 mm in diameter. The teeth are irregularly superposed in several layers separated by bony tissue, not in direct vertical piles, and have a very smooth, rounded,

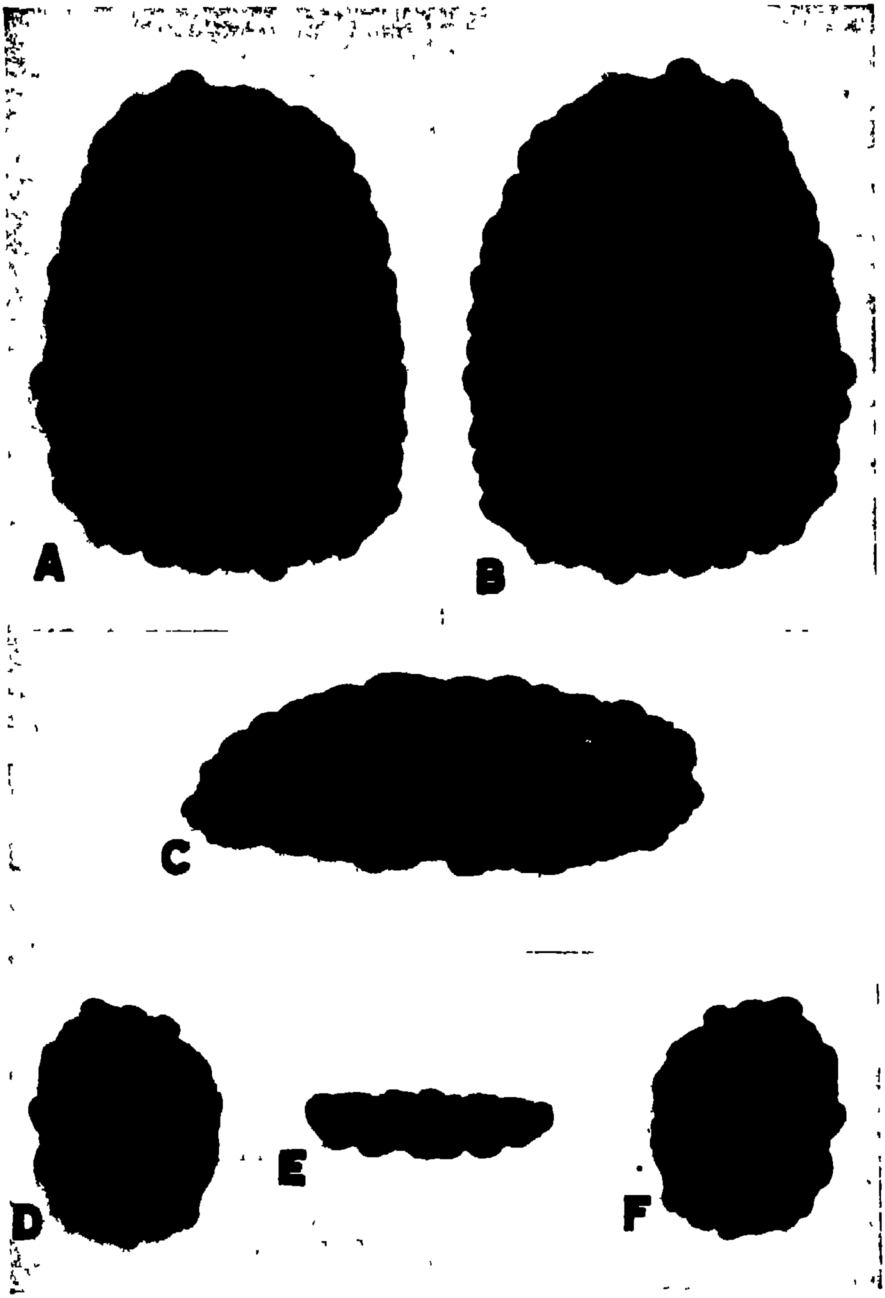

Fig. 1.—A, *Paralbula marylandica*, tritoral surface; B, attached surface; C, lateral view; D, *Paralbula dorisiae*, tritoral surface; E, lateral view; F, attached surface. All × nearly 2.

depressed-hemispheric crown inflexed at base to form a horizontal, somewhat radially striate rim about 0.5 mm wide. On the attached surface, the specimen is somewhat more deeply eroded at the anterior end, and is there loosely and irregularly cellular, with occasional interspersed bases or interiors of teeth. The posterior half is better preserved and shows the bone cells arranged mostly in definite longitudinal rows, with on each side near the margin of the bone a shallow more or less wedge-shaped depression, bounded in front and on the inner side by a rather indefinite ridge, these evidently being the scars marking the points of attachment to the supporting pharyngeal bones.

Type.—U.S.N.M. no. 13855, collected on shore of Potomac River at Liverpool Point, Charles County, Md., October 13, 1935, by Doris H. Blake. The deposits at this point, from which the specimen undoubtedly came, belong to the Piscataway member of the Aquia formation, Lower Eocene.

In my own collection is a detached tooth with eroded base, measuring 4.5 mm in diameter, and evidently belonging to the same species, which I picked up on the beach at the same locality in 1938.

As this paper was being prepared for publication, Mrs. Blake picked up on the beach near the wharf at Plumpoint, Md., a much smaller and more imperfect specimen that seems to represent a second species of the genus. The teeth are higher in proportion to their width, the root is more slanting and much more strongly grooved, and the opening in its center, which is scarcely at all excavated, is much smaller. As no Eocene deposits are exposed within miles of Plumpoint, it seems necessary to ascribe this specimen to the Miocene, and probably to the Calvert formation, the one best developed at Plumpoint.

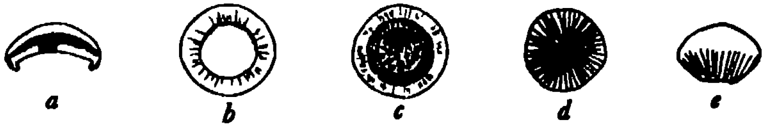

FIG. 2.—*a–c*, *Paralbula marylandica*. *a*, Cross section of tooth; *b*, view of tooth from beneath, showing the inflexed rim; *c*, view of scar left on oral surface of plate by a detached tooth. The outer ring, which is somewhat impressed and slants slightly toward the center, represents the area occupied by the inflexed rim of the tooth; the inner ring, which is elevated above the outer, is evidently a ring of denser bony tissue subtending the tooth inside the inflexed rim, and fitting against the somewhat beveled inner edge of the rim; the central circle is cellular bony tissue. *d–e*, *Paralbula dorisiae*; *d*, Typical tooth from beneath; *e*, from the side. All ×5.

Paralbula dorisiae Blake, sp. nov.

An irregularly oval, much eroded dental plate 15.5 mm long, 12 mm wide, and about 4 mm deep, obscurely convex in cross section on oral surface and essentially plane in longitudinal section, flattish on attached surface. Triturating surface densely covered with blackish brown to light brown, subcircular, depressed-subspherical teeth, about 40 in all (including bases of broken-off teeth), not arranged in definite lines, 1.5–2.2 mm in diameter, 1.2–1.7 mm deep. Teeth irregularly superposed in about three layers, or perhaps more in the center of the plate, separated by bony tissue, not in direct vertical piles, with a smooth, almost hemispherical crown and strongly striate, slanting root often almost equaling the height of the crown and tapering to a subtruncate tip 0.8–1 mm wide. The cavity left in the bone by detached teeth is deeper than that in *P. marylandica*, with more strongly grooved sides, and the striated inner ring is not at all elevated; the central area is perforate in all the cavities visible in the specimen.

Type.—U.S.N.M. no. 16134, collected on shore of Chesapeake Bay close to and just south of the wharf at Plumpoint, Calvert County, Md., August 13, 1939, by Doris H. Blake. Probably from the Calvert formation of the Miocene, the best developed formation in the vicinity of Plumpoint.

BOTANY.—*Miscellaneous new American grasses*.[1] JASON R. SWALLEN, U. S. Bureau of Plant Industry.

During the identification of various collections of grasses in the past few years, the following species were found to be new, three of which are from the United States, i.e., *Poa fibrata*, *Stipa diegoensis*, and *Digitaria albicoma*.

Chusquea sulcata Swallen, sp. nov.

Culmi graciles ramis floriferis fasciculatis adscendentibus 10–25 cm longis; vaginae internodiis longiores, glabrae, in ore hispidae marginibus ciliatis, ligula 0.5 mm longa, truncata, laminae 6–12 cm longae, 4–6 mm latae, acuminatae, glabrae marginibus sparse papilloso-hispidis; paniculae 4–10 cm longae, 5–10 mm latae, densae, ramis brevibus appressis; axis pubescens, glumae minutae obtusae enerves; lemmata sterilia obtusa vel subacuta, obscure 1–5-nervia, 2.5–3 mm longa; lemma fertile 6–7 mm longum, subacuminatum, obscure 7-nerve, exaristatum, glabrum; palea lemma aequans, sulcata, carinis approximatis pubescentibus, marginibus latis; antherae 4 mm longae.

Culms slender, probably clambering, the flowering branches in rather small ascending fascicles, 10–25 cm long, sheaths longer than the internodes, glabrous on the back, hispid in the throat, the margins ciliate; ligule about 0.5 mm long, truncate; blades 6–12 cm long, 4–6 mm wide, acuminate, narrowed toward the base, glabrous, sparsely papillose-hispid on the margins; panicles 4–10 cm long, 5–10 mm wide, rather dense, the short branches appressed, floriferous to the base, the axis glabrous or obscurely scabrous on the angles; glumes minute, obtuse, nerveless; sterile lemmas obtuse or subacute, apiculate, 1–5-nerved, the lateral nerves often obscure, ⅓ to ½ as long as the floret; lemma 6–7 mm long, subacuminate, obscurely 7-nerved, awnless, glabrous; palea as long as the lemma, sulcate, the keels close together, pubescent, the broad glabrous margins enclosing the flower; anthers 4 mm long.

Type in the U. S. National Herbarium, no. 1722000, collected on Mount Orando, Chiapas, Mexico, April 1936, by E. Matuda (no. 321).

This species superficially closely resembles *C. nelsoni* Scribn., which has shorter and broader blades, pubescent panicle axis, larger glumes, acuminate, sterile lemmas, and strongly nerved, sparsely pilose, fertile lemma.

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[1] Received October 26, 1939. All drawings by Mrs. Frances C. Weintraub.

Chusquea longifolia Swallen, sp. nov.

Rami floriferi dense fasciculati adscendentes 20–60 cm longi; laminae 12–25 cm longae, 6–12 mm latae, marginibus scabris; paniculae 10–16 cm longae, angustae ramis gracilibus appressis paucifloris scabris; spiculae 12–13 mm longae appressae; glumae obtusae, enerves, prima 0.5 mm secunda 1 mm longa; lemma sterile primum 7–9 mm longum, 9-nerve, acutum, apiculatum, basi latum; lemma sterile secundum lemma fertile aequans, 9-nerve, acuminatum, superne scabrum, lemma fertile 11–12 mm longum, obscure nervosum, puberulum, acuminatum, minute bifidum, aristatum, arista 2–4 mm longa; palea lemmate fertili paulo longior, carinis approximatis, bidentata, marginibus latis.

Main culm about 5 mm thick (in flowering part) the flowering branches fascicled, ascending, 20–60 cm long; blades 12–25 cm long, 6–12 mm wide with scabrous margins; panicles 10–16 cm long, narrow, the slender branches appressed, scabrous, few-flowered; spikelets 12–13 mm long, appressed; glumes obtuse, nerveless, the first 0.5 mm long, the second 1 cm long; first sterile lemma 7–9 mm long, 9-nerved, acute, mucronate, very broad at the base; second sterile lemma as long as the fertile one, 9-nerved, acuminate, scabrous toward the tip; fertile lemma 11–12 mm long, obscurely nerved, puberulent, acuminate, minutely bifid, with an awn 2–4 mm long; palea as long as or a little longer than the lemma, bidentate, the keels approximate, the margins very broad, incurved.

Type in the U. S. National Herbarium, no. 1724503, collected on Mount Tacana, Chiapas, Mexico, altitude 2,000–4,088 meters, in August 1938, by E. Matuda (no. 2373).

Poa fibrata Swallen, sp. nov.

Perennis, rhizomatosa; culmi rigidi, erecti vel basi adscendentes, 15–35 cm alti, glabri vel scaberuli; vaginae inferiores tenues, lucidae, undulatae, fibrosae, glabrae, superiores internodiis longiores, firmae, scabrae; ligula 1–1.5 mm longa acute vel obtusa; laminae 4–8 cm longae vel supreme reductae firmissimae, conduplicatae, curvatae, scabrae, marginibus minute serratis; panicula 4–10 cm longa, densa, ramis brevibus appressis ad basin floriferis vel basi nudis, scabris; spiculae 3–4 florae, 5–6 mm longae; glumae acutae vel subobtusae, 1–3-nerves, prima 2–3 mm longa, secunda 3 mm longa; lemmata 2.5–3 mm longa, acuta vel subobtusa, glabra vel scabra vix pubescentia; palea subacuta, lemma subaequans; antherae 2 mm longae.

Perennial with slender, creeping rhizomes; culms 15–35 cm tall, rigid, erect from an ascending base, glabrous or scaberulous; lower sheaths thin, smooth and shining, undulate, becoming more or less fibrous with age, the upper sheaths longer than the internodes, firm, scabrous; ligule 1–1.5 mm long, acute or subobtuse; blades 4–8 cm long, or the uppermost sometimes reduced, very firm, conduplicate, curved, pungent, scabrous, the margins minutely serrate; panicle 4–10 cm long, dense, with short appressed branches floriferous to the base, or the lower ones sometimes naked at the base, scabrous; spikelets 3–4-flowered, 5–6 mm long; glumes acute or subobtuse, 1–3-nerved, the first 2–3 mm long, the second 3 mm long; lemmas 2.5–3 mm long, acute or subobtuse, glabrous or scabrous, sometimes rather obscurely pubescent near the base and on the margins; palea subacute, about as long as the lemma or a little shorter.

Type in the U. S. National Herbarium, no. 1646953, collected in a dry subsaline flat, 2 miles south of Grenada, Shasta Valley, Siskiyou County, Calif., altitude 2,600 feet, June 30, 1935, by Louis C. Wheeler (no. 3629).

Poa mulleri Swallen, sp. nov.

Perennis; culmi caespitosi erecti 25–40 cm alti, compressi; foliae prope basin congestae; vaginae carinatae glabrae, eae culmorum elongatae; ligula 0.5 mm longa, membranacea, truncata; laminae innovationum laxae, elongatae, involutae, eae culmorum planae, 3–6 cm longae, 1–2 mm latae, glabrae; paniculae 5–8 cm longae pyramidatae; rami solitarii vel bini, graciles, flexuosi, reflexi, ad 3 cm longi, basi nudi; spiculae biflorae, 4 mm longae; gluma prima 3 mm longa, 3-nervis, acuta, navicularis; gluma secunda 3.5 mm longa, 5-nervis, abrupte acuta; lemma inferius 3.5 mm longum, 5-nerve, acutum, carina et nervis marginalibus inferne pubescentibus; palea lemmate paulo brevior; antherae 2 mm longae.

Perennial; culms loosely cespitose, 25–40 cm tall, erect from an ascending base, conspicuously flattened; leaves mostly crowded toward the base of the culms; sheaths compressed keeled, glabrous, those of the culm elongate; ligule 0.5 mm long, truncate; blades of the innovations lax, elongate, involute, those of the culm flat, 3–6 cm long, 1–2 mm wide, glabrous; panicles 5–8 cm long, pyramidal, the branches solitary or in pairs, slender, flexuous, reflexed, the lower ones as much as 3 cm long, naked in the lower half; spikelets clustered on the upper half of the branches, appressed, short pediceled, 2-flowered; glumes navicular, the first 3 mm long, 3-nerved, the second 3.5 mm long, 5-nerved, usually rather abruptly acute; lower lemma 3.5 mm long, 5-nerved, acute, sparingly pubescent on the keel and marginal nerves toward the base; palea a little shorter than the lemma; anthers 2 mm long.

Type in the U. S. National Herbarium, no 1645320, collected in pine woods on the Peak of Cerro Potosi, Municipio de Galeana, Nuevo Leon, Mexico, July 21, 1935, by C. H. Muller (no. 2251).

The very flat culms with short reflexed panicle branches are characteristic.

Stipa linearis Swallen, sp. nov.

Perennis; culmi graciles, dense caespitosi, erecti, 50–75 cm alti, 2-nodes; foliae ad basin dense congestae; vaginae culmorum elongatae internodiis breviores, subplanae, glabrae, eae innovationum breves, angustae; ligula brevissima vel ad 3 mm longa; laminae culmorum 3–10 cm longae, planae vel involutae, eae innovationum ad 35 cm longae, 1–1.5 mm latae, planae vel subinvolutae, infra glabrae supra scaberulae, marginibus scabris; panicula ad 13 cm longa, angusta, ramis gracilibus, appressis, paucifloris, 1–3.5 cm longis; glumae aequales 5 mm longae, acutae, prima 3–5-nervis, secunda 5-nervis; lemma 4–4.5 mm longum, fuscum, sparse pilosum; callum 0.5 mm longum, hebes, dense barbatum; arista 2 cm longa, bigeniculata.

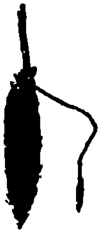

Fig. 1.—*Stipa linearis*, mature floret, ×1, and the body of the lemma, ×5.

Perennial; culms slender, densely cespitose, erect, 2-noded, 50–75 cm tall, the numerous leaves of the innovations crowded toward the base in a dense cluster; culm sheaths elongate, shorter than the internodes, becoming almost flat, glabrous, those of the innovations short, narrow; ligule very short in the innovations, 1.5–3 mm long on the culm leaves; culm leaves 3–10 cm long, flat or involute, those of the innovations as much as 35 cm long, 1–1.5 mm wide, flat or subinvolute, glabrous below, scaberulous above, the margins scabrous; panicle up to 13 cm long, narrow, the slender appressed, few-flowered branches 1–3.5 cm long; glumes equal, 5 mm long, acute, green, hyaline toward the tip, the first 3–5-nerved, the second a little broader, always 5-nerved; lemma 4–4.5 mm long, abruptly narrowed to the asymmetrical summit, dark brown, sparsely pilose with pale or brownish hairs; callus 0.5 mm long, blunt, densely barbate; awn 2 cm long, somewhat obscurely twice geniculate.

Type in the U. S. National Herbarium, no. 1610598, collected in Diente Canyon, 12 miles south of Monterrey, Nuevo Leon, Mexico, July 13, 1933, by C. H. Muller (no. 433).

This species is closely related to *Stipa augustifolia* Hitchc., which is a smaller plant, 10–30 cm tall, with short involute blades and longer glumes and lemma.

Stipa acuta Swallen, sp. nov.

Perennis; culmi graciles caespitosi, erecti, ad 95 cm alti; vaginae internodiis breviores, glabrae; ligula 1.5–2 mm longa vel eae innovationum brevissimae; laminae involutae ad 23 cm longae, firmae, glabrae, marginibus scabris; paniculae longe exsertae, 15–20 cm longae, laxae, ramis gracilibus, adscendentibus vel divergentibus, basi nudis, paucifloris, ad 6 cm longis; spiculae appressae; glumae acutae, hyalinae, reticulatae, basi purpurascentes, prima 11–12 mm longa, 5-nervis, secunda 9–10 mm longa, 5–7-nervis; lemma 7 mm longum, fusiforme, fuscum, pilosum pilis albis appressis; callum 1 mm longum, pungens, dense pilosum; arista 4–4.5 mm longa, bigeniculata.

Perennial; culms slender, tufted, erect, about 95 cm tall, sheaths shorter than the internodes, glabrous; ligule 1.5 to 2 mm long, or very short on the innovations; blades involute as much as 23 cm long, firm, glabrous with scabrous margins; panicles long exserted, 15–20 cm long, lax, the slender ascending or spreading, somewhat flexuous glabrous branches naked at the base—usually in the lower half, few-flowered, as much as 6 cm long; spikelets appressed, the pedicels 2–5 mm long; glumes acute, hyaline, reticulate veined, tinged with purple at least toward the base, the first 11–12 mm long, 5-nerved, the second 9–10 mm long, 5–7-nerved; lemma 7 mm long, fusiform, very dark brown, rather densely appressed-pilose with white hairs; callus 1 mm long, sharp pointed, densely appressed pilose; awn 4–5 cm long, twice geniculate, scabrous, the terminal segment slender, somewhat flexuous, 3–3.5 cm long.

Type in the U. S. National Herbarium, no. 1760238, collected on rocky soil on Carneras Pass, 21 miles south of Saltillo, Coahuila, Mexico, September 1, 1938, by Forrest Shreve (no. 8545).

Stipa acuta is most closely related to *S. eminens* Cav., which has narrower, 3-nerved, acuminate glumes, a pale lemma 5–6 mm long, and a somewhat shorter awn.

Stipa diegoensis Swallen, sp. nov.

Perennis; culmi densi caespitosi, erecti, 70–100 cm alti, scaberuli, infra nodos densi pubescentes; vaginae inferiores internodiis longiores, superiores internodiis breviores, elongatae, glabrae vel scaberulae; ligula 1–2 mm longa, obtusa vel truncata, ciliata, pubescens; laminae 15–40 cm longae, 2–4 mm latae, planae vel involutae, attenuatae, infra scaberulae, supra pubescentes; panicula 15–30 cm longa, densa, angusta, ramis appressis ad 10 cm longis; gluma prima 9–10 mm longa, 1-nervis, acuminata; gluma secunda 8–9 mm longa, 3-nervis, acuminata; lemma 6.5–7.5 mm longum, pilosum, pilis supremis 1–2 mm longis; callum 0.5 mm longum, curvatum, pungens, pilosum; arista 2–3.3 cm longa, bigeniculata, scabra; palea 4 mm longa, acuta, pilosa; antherae 4 mm longae, purpurascentes.

Perennial; culms densely tufted, erect, 70–100 cm tall, scaberulous, densely pubescent below the nodes; lower sheaths longer than the internodes, the upper ones shorter than the internodes, elongate, glabrous or scaberulous; ligule 1–2 mm long, obtuse or truncate, ciliate, pubescent; blades 15–40 cm long, 2–4 mm wide, flat or involute, scabrous on the lower surface, pubescent on the upper; panicle 15–30 cm long, narrow, dense, the branches appressed as much as 10 cm long, first glume 9–10 mm long, 1-nerved, acuminate; second glume 8–9 mm long, 3-nerved, acuminate; lemma 6.5–7.5 mm long, pilose, the hairs at the top of the lemma, 1–2 mm long, callus 0.5 mm long, curved, sharp-pointed, appressed pilose, awn 2–3.3 cm long, bigeniculate, scabrous; palea 4 mm long, acute, pilose; anthers 4 mm long, purple.

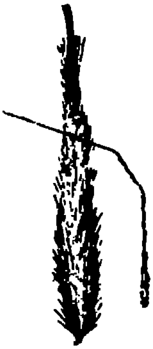

Fig. 2.—*Stipa diegoensis*, mature floret, ×1, and the body of the lemma, ×5.

Type in the U. S. National Herbarium, no. 1761177, collected along vernal stream in chaparral, Proctor Valley near Jamul, San Diego County, Calif., May 23, 1938, by Frank F. Gander (no. 5778).

This species is apparently related to *S. editorum* Fourn., which is a much more slender plant, glabrous below the nodes and has thinner glumes, the second 1-nerved or obscurely 3-nerved, a shorter lemma 5–6 mm long, and a more slender obscurely geniculate awn.

Stipa bracteata Swallen, sp. nov.

Perennis; culmi ad 125 cm alti, caespitosi, erecti, 3-nodes, infra nodos dense retrorse pubescentes, infra paniculam bracteatae; vaginae internodiis breviores inferne pubescentes, in ore sparse pilosae; ligula 1.5–3 mm longa, laminae 25–40 cm longae, 1–3 mm latae, planae vel involutae, infra glabrae, supra pubescentes; panicula 35–42 cm longa, laxa, fasciculis ramorum remotis; rami graciles 4–10 cm longi adscendentes vel divergentes, basi nudi; spiculae appressae; glumae acuminatae, hyalinae, 3-nerves, prima 10–11 mm longa, secunda 8–9 mm longa; lemma 5.5–6.5 mm longum, fusiforme, fuscum, pilosum pilis albis appressis; callum 0.5 mm longum, curvatum, dense barbatum; arista 20–24 mm longa, bigeniculata, glabra.

Perennial; culms as much as 125 cm tall, erect, tufted, 3-noded, densely retrorsely pubescent below the nodes, with a conspicuous ciliate bract 4–6 mm long below the panicle; sheaths shorter than the internodes, pubescent near the base, sparsely pilose at the throat, those of the innovations densely pubescent on the collar; blades 25–40 cm long, 1–3 mm wide, flat or involute, glabrous on the lower surface, pubescent on the upper; panicle 35–42 cm long, lax, the branches in small remote fascicles, 4–10 cm long, some long and some short in the same fascicle, slender, ascending or spreading, naked at the base, the longer ones usually spikelet bearing only near the ends; spikelets appressed; glumes acuminate, hyaline, 3-nerved, the first 10–11 mm long, the second 8–9 mm long; lemma 5.5–6.5 mm long, fusiform, brown, pilose with white appressed hairs; callus 0.5 mm long, somewhat curved, rather blunt, densely barbate; awn 20–24 mm long, bigeniculate, glabrous or nearly so, the two lower segments twisted, the upper straight.

Type in the U. S. National Herbarium, no. 1721797, collected on grassy flats 25 miles north of Ensenada, Baja California, April 4, 1931, by Ira L. Wiggins (no. 5153).

Stipa bracteata is related to *S. editorum* and *S. diegoensis* but is at once distinguished by the conspicuous bract below the panicle

Digitaria albicoma Swallen, sp. nov.

Perennis; culmi caespitosi, erecti, 65–71 cm alti, simplices vel basi ramosi; vaginae inferiores internodiis multo longiores, dense villosissimae, superiores elongatae internodiis breviores, glabrae vel ad basin papilloso-pilosae; ligula 1.5–2 mm longa, truncata; laminae planae, 10–30 cm longae, 3–5 mm latae, pilosae vel papilloso-pilosae, marginibus scabris; panicula longe exserta; racemi 5–9, graciles, adscendentes vel divergentes, 8–12 cm longi basi nudi; spiculae 2.5-mm longae, solitariae vel binae, inferior subsessilis, superior pedicello scabro 2 mm longo; gluma prima obsoleta; gluma secunda angusta 3-nervis, glabra, marginibus hyalinis; lemma sterile lemma fertile aequans, subobtusum, 5–7-nerve, glabrum, marginibus hyalinis; fructus 2.5–2.8 mm longus, acutus, plumbeus.

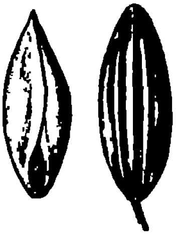

Fig. 3.—*Digitaria albicoma*, spikelet and fruit, ×5

Perennial; culms cespitose, erect, 65–75 cm tall, simple, or branched at the base; lower sheaths much shorter than the internodes, densely villous, the upper ones elongate but shorter than the internodes, glabrous or papillose-pilose toward the base; ligule 1.5–2 mm long, truncate; blades flat, 10–30 cm long, 3–5 mm wide, pilose or papillose-pilose, the margins scabrous; panicle long exerted; racemes 5–9 slender, ascending or spreading, 8–12 cm long, naked at the base; spikelets 2.5 mm long, solitary or paired, the lower one subsessile, the upper pedicellate, the pedicel 2 mm long, scabrous; first glume obsolete or nearly so; second glume narrow, 3-nerved, glabrous, the margins hyaline; sterile lemma as long as the fruit, 5–7-nerved, glabrous, the margins hyaline; fruit 2.5–2.8 mm long, acute, lead-colored.

Type in the U. S. National Herbarium, no. 1761179, collected in low open sandy woods, Chinsegut Hill Sanctuary, Brooksville, Hernando County, Fla., November 18, 1938, by Jason R. Swallen (no. 5644).

Digitaria albicoma is closely related to *D. subcalva* Hitchc., which has many noded culms decumbent at the base and sometimes rooting at the lower nodes, less conspicuously villous sheaths, and fewer appressed racemes.

Mesosetum comatum Swallen, sp. nov.

Perenne; culmi graciles, erecti, 50 cm alti; vaginae internodiis longiores, glabrae, in ore pilosae, marginibus minute ciliatis; laminae 4–6 cm longae, 2–2.5 mm latae, superiores et eae innovationum reductae, firmae, erectae, pungentes, infra glabrae, supra glabrae vel hispidae, marginibus sparse hispidis; gluma prima 3.5 mm longa, obtusa, basi hirsuta pilis ad 4 mm longis, in parte superiore scabra; gluma secunda 3 mm longa, 3-nervis, basi pilosa, superne glabra, marginibus breviter ciliatis, lemma sterile 4 mm longum, acutum, marginibus ciliatis pilis 2–2.5 mm longis, quam pilis glumae secundae crassioribus; lemma fertile 3.8–4 mm longum, minute striatum.

Perennial; culms slender, erect, about 50 cm tall; sheaths as long as or longer than the internodes with a small tuft of hairs in the throat and a pubescent line on the collar, the back glabrous, the margins finely ciliate; ligule about 0.2 mm long, ciliate; blades 4–6 cm long, 2–2.5 mm wide, the uppermost culm blades and those on the innovations much reduced, firm, erect, pungent, involute toward the tip, the lower surface glabrous, becoming hispid toward the tip, the upper surface glabrous or hispid, the margins sparsely papillose-hispid; raceme 7 cm long, erect; spikelets appressed; first glume 3.5 mm long, obtuse, obscurely keeled, not greatly narrowed toward the base, hirsute across the lower part, some of the hairs as much as 4 mm long, sparsely hirsute on the midnerve to the middle, the upper dorsal portion scabrous; second glume 3 mm long, 3-nerved, the tip rounded, glabrous on the back, pilose toward the base, the margins evenly appressed ciliate nearly to the summit; sterile lemma 4 mm long, acute, the margins densely ciliate, the hairs 2–2.5 mm long, coarser than those on the second glume, fruit 3.8 mm long, minutely striate.

Type in the U. S. National Herbarium, no. 1721241, collected at San Ignacio, Cerro Piedras, Province of Misiones, Argentina, March 10, 1914, by Rodrigues (no. 31). This specimen was communicated by L. R. Parodi, Buenos Aires, Argentina.

Mesosetum comatum resembles *M. loliiforme* (Hochst.) Chase, which is a stoloniferous plant with smaller appressed pilose spikelets, the sterile lemma not conspicuously fringed.

Panicum abscissum Swallen, sp. nov.

Perenne; culmi densi caespitosi, 55 cm alti, compressi; vaginae inferiores carinatae, 3–4 mm latae (e carina ad marginem), truncatae, ad basin culmorum congestae, superiores longiores, internodiis breviores, auriculatae; ligula curtissima; laminae 15–25 cm longae, 1–2 mm latae, conduplicatae, firmae, curvatae vel flexuosae, infra glabrae supra scaberulae; paniculae terminales et axillares, 7–15 cm longae, ramis adscendentibus vel appressis, paucifloris, ad 10 cm longis; pedicelli 1–4 mm longi appressi; spiculae 2.8–3 mm longae; gluma prima 1.6–2 mm longa, 3-nervis, acuta, carina scabra; gluma secunda et lemma sterile aequalia, 5-nervia, subobtusa, glabra; fructus 2.2–2.3 mm longus, 0.5 mm latus, acutus, pallidus, nitens.

Perennial; culms densely cespitose, 50–70 cm tall, compressed; lower sheaths keeled, somewhat crowded, 3–4 mm wide from keel to margin, one side of the sheath sometimes 5–8 mm longer than the other, truncate or extended at the summit into short, very broad, obtuse auricles, the upper sheaths much longer than the lower but much shorter than the internodes, the auricles not so prominent; ligule membranaceous, very short; blades 15–25 cm long, 1–2 mm wide, conduplicate, firm, curved or flexuous, glabrous on the lower surface, scabrous on the upper; panicles terminal and axillary from all the nodes, long exserted, 7–15 cm long, the branches ascending or appressed; spikelets 2.8–3 mm long; first glume 1.6–2 mm long, 3-nerved, acute, scabrous on the keel; second glume and sterile lemma equal, 5-nerved, subobtuse, glabrous; fruit 2.2–2.3 mm long, 0.5 mm wide, acute, pale, smooth and shining.

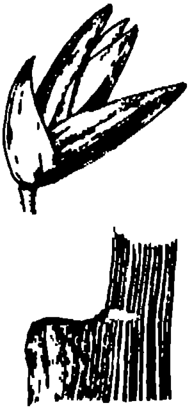

Fig. 4.—*Panicum abscissum*, spikelet and mouth of sheath, ×5.

Type in the U. S. National Herbarium, no. 1259952, collected in dry sand at tourist camp near lake, Sebring, Fla., October 3, 1925, by Paul Weatherwax.

Panicum abscissum belongs to the *Agrostoidea* group of *Panicum*. It is distinguished from all the other species of the group by the broad sheaths truncate at the summit, the firm flexuous blades, and the axillary panicles from all the nodes.

Distribution: Sandy or swampy ground, central Florida. De Soto County: Sebring, *Weatherwax* in 1925 (type), Polk County: Winter Haven, *O'Neill* 5207, 5208, Florinda, *Piper* in 1917.

Panicum irregulare Swallen, sp. nov.

Perenne; culmi 80 cm longi, prostrati, ramosi, radicantes, glabri; vaginae internodiis breviores vel superiores internodiis longiores, glabrae, in ore pubescentes; laminae 4.5–6.5 cm longae, 1–1.5 cm latae, ovato-lanceolatae, acuminatae, glabrae, marginibus albis; paniculae 16–17 cm longae, racemis 15 remotis adscendentibus 1–2.5 cm longis; spiculae biflorae, binae, 2–2.2 mm longae, prima subsessilis, secunda pedicellata; gluma prima 0.7–1 mm longa, 1-nervis, acuta; gluma secunda et lemma flosculi primi subaequalia, acuta, 5-nervia, glabra; palea flosculi primi 1.5 mm longa, hyalina; caryopsis libera; fructus 1.5 mm longus, acutus, lucidus

Perennial; culms 80 cm long, prostrate spreading, ascending at the ends, branching, rooting at the lower nodes; sheaths shorter than the internodes or the upper ones a little longer than the internodes, glabrous, pubescent at the mouth; blades short pedicellate, 4.5–6.5 cm long, 1–1.5 cm wide, ovate-lanceolate, acuminate, with white cartilaginous margins; panicles 16–17 cm long with 15 rather remote ascending racemes 1–2.5 cm long; spikelets rather densely arranged on one side of the rachis, 2-flowered, paired, 2–2.2 mm long, spreading, the first subsessile, the second pedicellate; first glume 0.7–1 mm long, 1-nerved, acute; second glume and lemma of the first floret similar, subequal, acute, 5-nerved, palea of first floret 1.5 mm long, hyaline; caryopsis free; fruit 1.5 mm long, acute, smooth and shining.

Type in the U. S. National Herbarium, no. 1644874, collected on stony river bank in the vicinity of El General, Province of San Jose, Costa Rica, altitude 760 meters, February 1939, by Alexander F. Skutch (no. 4115).

Panicum irregulare is related to *P. frondescens* Meyer, which has a denser, shorter panicle of more numerous racemes and larger spikelets 2.6–2.8 mm long with the lower floret sterile.

BOTANY.—*Arizona plants: New species, varieties, and combinations.*[1]

F. J. HERMANN, T. H. KEARNEY, and R. H. PEEBLES, U. S. Bureau of Plant Industry.

A paper on this subject appeared in this JOURNAL on November 15, 1939 (**29**: 474–492). A few additional novelties have since come to light, and they are published here in order to avoid publication of new names in a flora of Arizona, now in preparation.

Juncus interior Wieg. var. **arizonicus** (Wieg.) Hermann, comb. nov.

Juncus arizonicus Wieg., Bull. Torrey Bot. Club **27**: 517. 1900.

Juncus interior Wieg. var. **neomexicanus** (Wieg.) Hermann, comb. nov.

Juncus neomexicanus Wieg., Bull. Torrey Bot. Club **30**: 447. 1903.

Both *J. arizonicus* and *J. neomexicanus* possess the acuminate to aristate bracteoles of *J. interior*, which set this species off from its nearest allies. Intermediates are frequent between the two varieties here proposed and typical *J. interior*, but most material falls rather readily into one of the three forms and may be distinguished by the following key:

- Perianth equaling the capsule, 3–4 mm long . . . *J. interior*
- Perianth exceeding the capsule, 4–5 mm long
  - Bracteoles lanceolate, acuminate, perianth-segments erect, rigid, lanceolate, their hyaline margins relatively narrow and opaque . . . . *J. interior* var. *arizonicus*
  - Bracteoles broadly ovate, acute to abruptly aristate; perianth-segments spreading, not rigid, broadly ovate, with broad transparent scarious margins and brown lateral bands bordering the green center. . . . . *J. interior* var. *neomexicanus*

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[1] Received February 1, 1940.

Juncus longistylis Torr. var. **scabratus** Hermann, var. nov.

A varietate typica recedit foliis pedicellisque scabratis.

Of the 20 collections of *J. longistylis* seen from Arizona, 9 represent the typical form of the species and, except for one specimen from the Huachuca Mountains (Cochise County), all are from the northern half of the State. The others have the vegetative parts scabrate much as in the eastern *J. caesariensis* Coville, and the auricles show a tendency to be prolonged, free, and acute. The scabrosity is most conspicuous upon the pedicels and the terminal portions and margins of the leaves. Intergradations with the typical form are found in various degrees, however. The following collections in the U. S. National Herbarium are characteristic of var. *scabratus:* Near Prescott, alt. 5,350 feet, Yavapai County, *Peebles, Harrison, & Kearney* 2712, August 8, 1926 (TYPE); Willow Springs, Apache, County *E. Palmer* 556 (in part) and 624 (in part), July 1890.

Juncus tracyi Rydb f. **utahensis** (Martin) Hermann, comb nov.

J. utahensis Martin, Rhodora 40: 69–71. 1938

Juncus tracyi manifests two forms, a few-headed, many-flowered phase, characterized by the type specimen of Rydberg's species, and a many-headed, few-flowered phase, represented by the type specimen of *J. utahensis*. The extremes of these forms are strikingly different in appearance yet intermediates are plentiful and there is no apparent geographic segregation of the extremes *Juncus ensifolius* Wikstr , *J. phaeocephalus* Engelm., *J. saximontanus* A. Nels., *J. canadensis* J Gay, and *J acuminatus* Michx are other species that exhibit a parallel series of forms

Juncus saximontanus A. Nels. f. **brunnescens** (Rydb.) Hermann, comb. nov.

Juncus brunnescens Rydb , Bull Torrey Bot Club 31: 400 1904.

This form shows the same instability as does *J. tracyi* f *utahensis* and like it seems to have no geographic significance. The extremes may be distinguished by the following key:

Inflorescence composed of few (seldom more than 10) heads, which average 7–10 mm in diameter and are many (15 to 25)-flowered . . . . . *J. saximontanus*

Inflorescence composed of numerous (usually more than 10) heads, which average 5–6 mm in diameter and are few (5 to 12)-flowered . . . *J. saximontanus* f. *brunnescens*

Astragalus cobrensis Gray var. **maguirei** Kearney, var. nov.

Ab *A. cobrensi* f. typica pilis longioribus patentibus, foliolis supra parce pubescentibus, calycis dentibus quam tubo longioribus, recedit.

Type from White Tail Canyon, Chiricahua Mountains, Cochise County, Ariz., in sandy soil under oak and walnut, *Bassett Maguire et al.* 11079, May 2, 1935 (U. S. National Herbarium no. 1768940).

The variety here described has rather long spreading hairs on the herbage and pods, leaflets sparsely pubescent above, and calyx with teeth longer than the tube, whereas in typical *A. cobrensis* the hairs are shorter and appressed, the leaflets glabrous above, and the calyx-teeth about as long as the tube. The flowering stems in var. *maguirei* (probably also in *A. cobrensis*) arise from long, slender, creeping rootstocks.

Astragalus cobrensis, known only from southwestern New Mexico, is sparingly represented in herbaria, and var. *maguirei* is known only by the type collection. Study of additional material of these forms may prove *maguirei* to be a distinct species.

Echinocereus robustus Peebles, sp. nov.

Echinocereus rectispinus Peebles var. *robustus* Peebles, Amer. Journ. Bot. 25: 675. 1938.

ZOOLOGY.—*The hairworm*, Gordius robustus *Leidy, as a parasite of the Mormon cricket*, Anabrus simplex *Haldeman.*[1] GERALD THORNE, U. S. Bureau of Plant Industry.

INTRODUCTION

Parasites effective against the Mormon cricket, *Anabrus simplex* Haldeman, apparently are very rare. It was, therefore, of considerable interest when there were reports of a heavy parasitism by *Gordius robustus* Leidy in the vicinity of Arrowrock Dam, Idaho (1). Visits to that locality were made by the writer on July 26 and October 9, 1935, and on May 16 and August 24, 1936. The unusual populations occurring there presented excellent opportunities for studying the parasite from the standpoint of life history, habits, host relationship, ecology, and economic importance. Specimens for more detailed examination and experiments were taken to the Salt Lake City, Utah, laboratory.

This observation of *Gordius robustus* coincided with the unprecedented populations of *Anabrus simplex* which first appeared at Fort Hall, Idaho, in May, 1932, and by August, 1936, had infested almost 2,000,000 acres in 24 counties of Idaho (11). Similar outbreaks of the cricket occurred in other western States (Fig. 1).

HISTORICAL

Gordius robustus Leidy, 1851, belongs to the rather common group of organisms known as "hairworms," the adults of which are usually found inhabiting warm shallow pools or streams. In its immature stages it is known as a parasite of certain insects, principally Orthoptera.

The first record of *Gordius robustus* in *Anabrus simplex* (synonym *A. pur-*

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[1] The writer is indebted to Claude Wakeland and R. W. Haegele, who gave valued preliminary information on the distribution of *Gordius robustus* in the Arrowrock section and joined in visiting the area on two occasions. J. Percy Moore, of the University of Pennsylvania, kindly lent the Leidy collection of *G. robustus* from Milk River, Mont., and Dr. Henry B. Ward forwarded the May collection from Urbana, Ill., for comparison with the Idaho and western Montana specimens collected in 1935. G. Steiner and Edna M. Buhrer have given valuable suggestions on the manuscript and bibliography. The map used in Fig. 1, giving the 1937 distribution of *Anabrus simplex*, is taken from a U. S. Department of Agriculture Press Service release, March 26, 1937. Received November 18, 1939.

purascens[3]) is given by Riley, Packard, and Thomas (9, footnote 83, p. 327), who mention "*Gordius robustus*, Leidy.—A ♂ from ♀ *Anabrus purpurascens* Uhler; in Mr. Riley's cabinet." No records remain as to the locality in which this specimen was collected Riley, Packard, and Thomas (10, p. 64) quote Bruner's remarks on parasites of the Mormon crickets observed along the Portneuf River, Idaho: "Hair-worms (*Gordius*), too, are frequently found wound about their intestines."

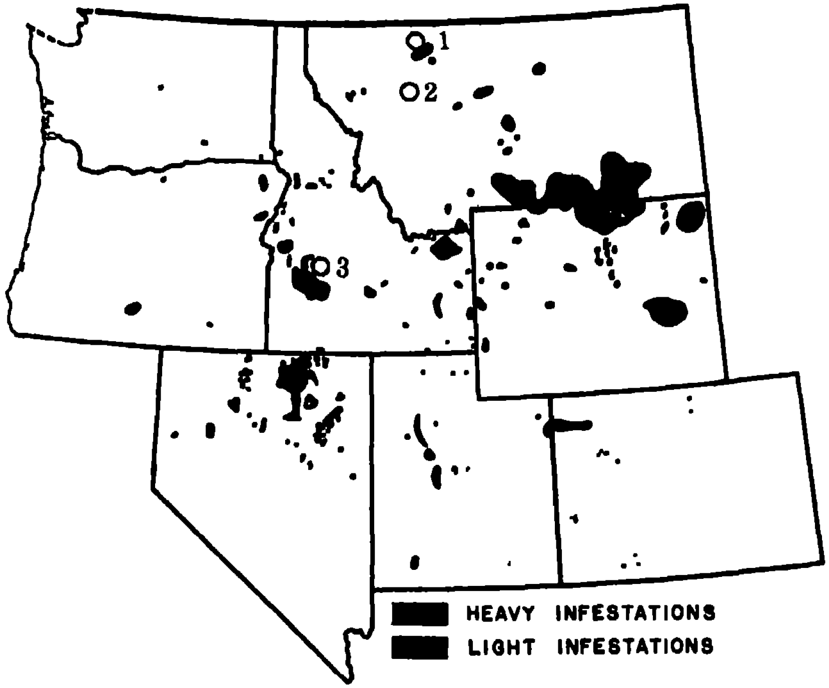

Fig. 1—Range of *Anabrus simplex* in 1937 and known distribution of *Gordius robustus*· 1, Cutbank, Mont ; 2, Augusta, Mont ; 3, Arrowrock Reservoir, Idaho

Leidy (3) reported *Gordius robustus* from New Jersey as a parasite of a grasshopper, later (5) identified as *Conocephalus fasciatus fasciatus* (DeGeer) (synonym *Orchelimum gracile* Harris), and (4) of the carabid beetle *Pterostichus* (*Gastrellarius*) *honestus* Say (synonym *Pterostichus fastiditus* Dej) Thomas (9) found a female in *Stenopalmatus fuscus* Haldeman (synonym *S. fasciatus* Thomas) at Wasatch, Utah. May (6) reports it in the vicinity of Urbana, Ill , as a frequent parasite of *Orchelimum vulgare* Harris, *O. nigripes* Scudder, *Conocephalus memoralis* (Scudder) (synonym *Xiphidium nemorale* Scudder), and occasionally *Phaneroptera furcata furcata* (Brunner) (synonym *Scudderia furcata* Brunner).

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[3] Synonyms given are the host names of the original records.

THE IDENTITY OF GORDIUS ROBUSTUS LEIDY, 1851

The type specimen of *Gordius robustus* from *Conocephalus fasciatus fasciatus* has not been preserved, but a collection from Milk River, Mont., made in 1876 and identified by Leidy, is still available This consists of four males and six females varying from 31 to 46 cm in length The hosts of these specimens are unknown, but they were collected within the range of *Anabrus simplex* and, judged from their size, it appears quite probable that they grew in these large insects. These 10 specimens are identical to those recently collected in Idaho and Montana except for their lighter color, which is due to bleaching during their long preservation in alcohol.

Leidy's original designation of the name *Gordius robustus* was given with a very meager description (3). Later (4, p. 57) he published a more detailed description but listed the species as a synonym of *G aquaticus?* Gmelin (which is *G. aquaticus* Linn., 1758). He followed the name with a question mark, indicating that his specific designation was questionable. Montgomery (7) placed the species as a variety, *G. aquaticus robustus;* but later (8) made it a synonym of *G. villoti* Rosa, 1882. May (6) considered *G robustus* as a valid species and prepared an excellent, detailed morphological description.

After examining the specimens from Milk River, Mont., the writer considers that May's action was fully justified. To further establish the fact, specimens from the Arrowrock section were sent to Kurt Heinze, a leading European authority on Gordioidea, who pronounced them as being neither *Gordius aquaticus* nor *G. villoti.*[3] Caballero (2) records both *G. robustus* and *G. aquaticus* from Mexico, thus supplying additional evidence that the two species are distinct.

Since Leidy determined the specimens from Milk River, Mont., as being the same as his type specimen of *Gordius robustus* from New Jersey and also in view of the fact that May found the species prevalent in Illinois, the writer has no basis for assigning the form to any other species

DISTRIBUTION OF GORDIUS ROBUSTUS AS A PARASITE OF ANABRUS SIMPLEX

A survey of the Arrowrock section on July 26, 1935 (Fig. 2), revealed that there was a great difference in the number of *Gordius* present in the various localities. They were most numerous on Elk Creek where tangled masses (Fig. 3) were present in almost every pool, and many more were scattered along the stream or buried in the loose gravelly soil or under rubbish. At Grouse Creek and near Long Gulch Ranger Station they were almost as numerous, while small numbers were present in Slide Gulch, Cottonwood, Highland Valley, and other points along the route.

After the first reports of the parasitism of Mormon crickets by a *Gordius*, workers in the various cricket infested areas of the Western States were on the alert for additional localities in which the hairworm might be present.

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[3] Personal communication dated February 20, 1937.

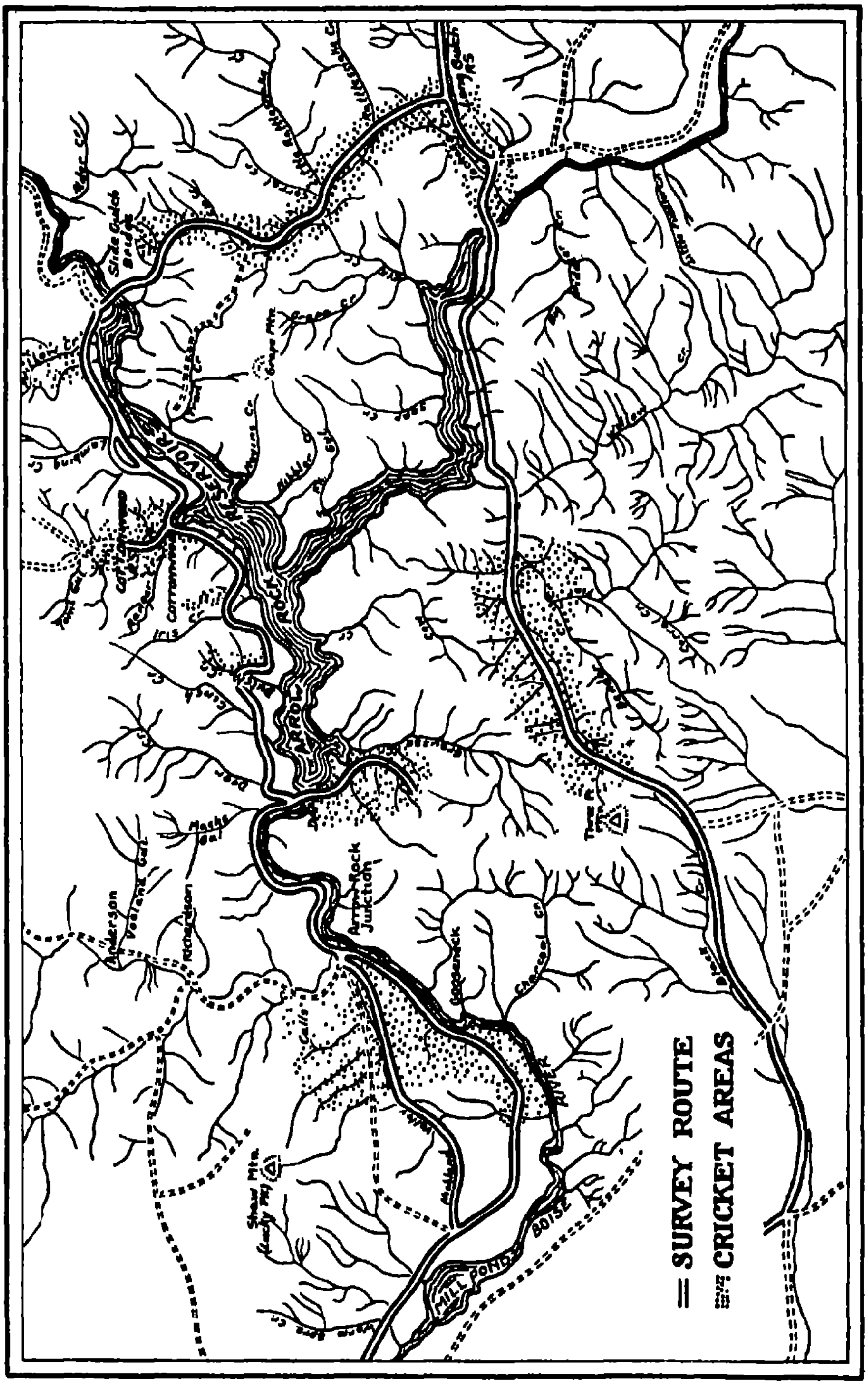

Fig. 2.—The Arrowrock Reservoir section showing survey route, July 26, 1935, and location of Mormon-cricket bands at that time.

However, the only places added were in Montana, where Frank Cowan and Horace J. Shipman, of the U. S Bureau of Entomology and Plant Quarantine, collected a considerable number near Cutbank and a single female near Augusta (Fig. 1).

ECONOMIC IMPORTANCE OF GORDIUS ROBUSTUS

Reliable reports indicate that between 25 and 50 percent of the Mormon crickets invading the Grouse Creek section early in July 1935, were parasitized by *Gordius robustus*, and this appeared to be corroborated by the great numbers present in the stream and buried in wet areas. At that time on Arrowrock Reservoir the crickets entered the water in great numbers, until patches 2 or 3 square rods in extent sometimes were floating about and from them large numbers of Gordii emerged and congregated along the shore. By July 26 it was evident that the larger portion had left their hosts, and it was difficult to find crickets in which Gordii still remained; between Arrowrock Dam and Grouse Creek only five parasitized crickets were found among 1,000 examined, and in other localities they were just as rare. However, the

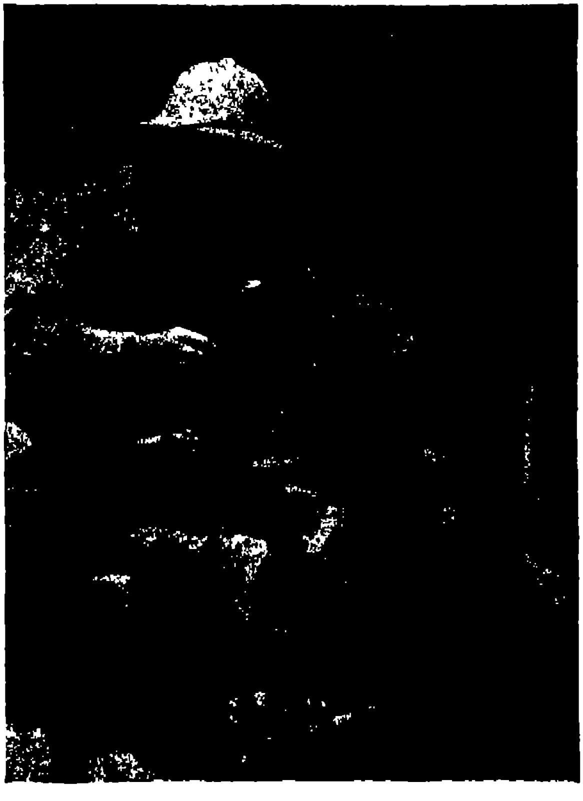

Fig. 3.—Entangled mass of *Gordius robustus* collected on upper Elk Creek.

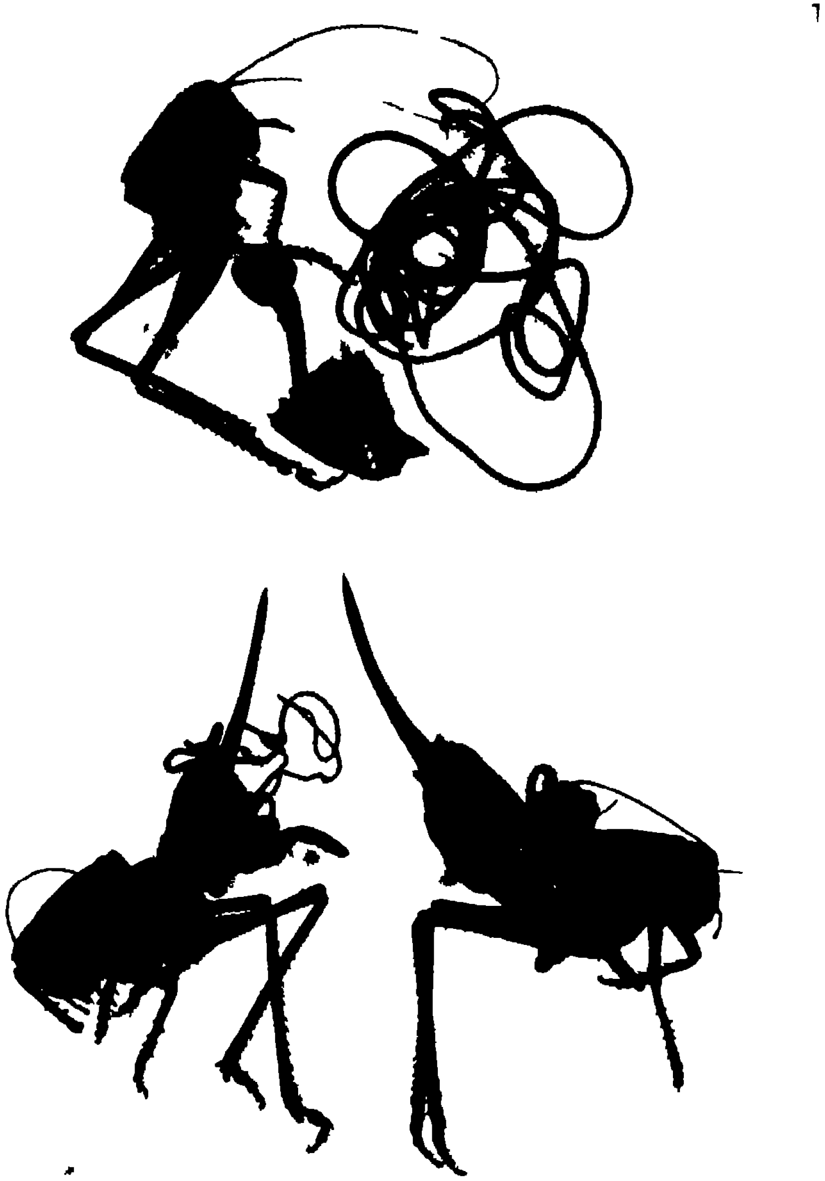

Fig. 4.—*Anabrus simplex* parasitized by *Gordius robustus*. Note in the top figure how thoroughly the body contents of the insect have been absorbed leaving only the alimentary canal. Natural size.

crickets are migratory, remaining in one locality only a short time, and it is probable that those observed by the writer were from different breeding areas than those in the earlier invasions.

Commenting on the parasitised crickets collected on September 26, 1935, near Cutbank, Mont., Horace J. Shipman wrote, "The parasitized crickets were found near a pond, which was the only one in the vicinity Crickets taken within 100 yards of the pond were approximately 99 percent parasitized, and only one of the crickets contained eggs. One mile north of this pond the crickets were about 50 percent parasitized."[4]

On July 20, 1936, Claude Wakeland[5] reported that about one-fourth of the crickets in the Slide Gulch and Rattlesnake localities near Arrowrock Reservoir were parasitized.

None of the parasitized crickets collected by the writer contained eggs The body cavity was invariably found to be completely filled with the parasite, and only the alimentary canal remained (Fig 4) The parasitized female containing a few eggs reported above by Shipman may have been a case of very late parasitism after the ovaries had been developed.

It is evident that female crickets parasitized by *Gordius robustus* rarely produce eggs, therefore, in regions of heavy parasitism the cricket population must be considerably reduced Since only a minor portion of the breeding grounds of the Mormon cricket lies near streams, ponds, and swamps suitable for the propagation of *Gordius*, the effective control exercised over the total cricket population during extensive outbreaks probably is negligible. The migratory habits of the cricket bring great numbers to streams where they may become parasitized but at the same time a large portion of these individuals wander far from water and die, the parasites being lost because water is essential to completion of their life cycle.

During the many years between extensive cricket outbreaks only small bands occur, and these generally are confined to the higher elevations where there is more abundant moisture. In those regions where *Gordius* is abundant the water-frequenting habits of the crickets no doubt bring practically all of them in contact with *Gordius*, and during such periods it seems quite probable that economically more effective parasitism occurs.

MORPHOLOGY OF GORDIUS ROBUSTUS

Adults--But little can be added to May's description of the adults (6). The specimens observed all correspond closely with his observations except in minor points, which apparently are due to individual variation Very light-colored specimens, especially females, apparently lack the dark dorsal and ventral bands and light-colored areas of the cuticle that May mentions, but they show distinctly on all the darker-colored females and males These markings were also absent on the bleached, alcohol-preserved specimens from the Leidy collection The branching hairs of the cuticle mentioned by Montgomery (7) could not be found, and since May also failed to observe them this statement must have been an error Considerable variation in the male postcloacal ridge occurred among the specimens collected, the most common form being slightly angular (Fig. 5, A), while a more angular type (Fig. 5, B) was comparatively rare.

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[4] Personal communication dated December 9, 1935.

[5] Personal communication dated June 20, 1936

The oral opening is degenerated to a minute scar (Fig. 5, C), which is visible only in a face view. In no instance was it observed that the larval spear remained within the oral aperture.

A brownish ring generally surrounds the cloacal opening of the female, but on occasional specimens it is entirely lacking. When present it varies considerably in its distinctness and width.

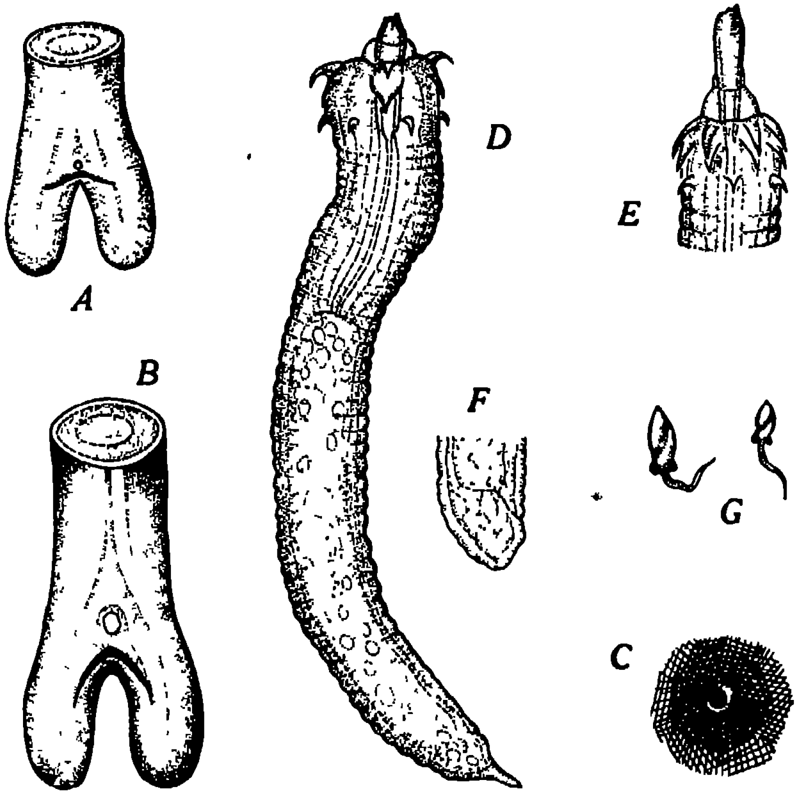

Fig. 5.—A, B, Male tails showing variations in the form of the cloacal ridge, ×25. C, Rudimentary oral opening, ×750. D, Larva, ×750. E, Head of larva with protruded proboscis, ×750. F, Posterior portion of larva with blunt terminus, ×750. G, Sperms, ×1500.

Specimens of *Gordius robustus* from *Anabrus simplex* frequently are very large. Wakeland and Shull (11) state that they reach a length of 48 inches (121.9 cm), and the writer collected a female 120.6 cm long. A random collection of 200 specimens contained 63 females varying in length from 13 cm to 120 cm and 137 males from 18 cm to 91 cm.

Eggs.—The slightly ovate eggs average about 38μ wide by 51μ long and are deposited in slender broken cords held together by a gelatinous mucus, which swells on contact with water until the egg cord is about 1 mm in diameter (Fig 6, A). The ovary occupies almost the entire body cavity, and the number of eggs produced by a female is enormous, those from a 106-cm female being estimated at 28,902,500. There is a short uterus, 2 to 3 mm long, in which huge numbers of minute spermatozoa (Fig. 4, G) can be found in fertilized females. The body of the spermatozoon appears to be somewhat flattened and concave, probably giving it a rotary motion as it is propelled by its tail. Fertilization of the eggs occurs as they pass through the uterus.

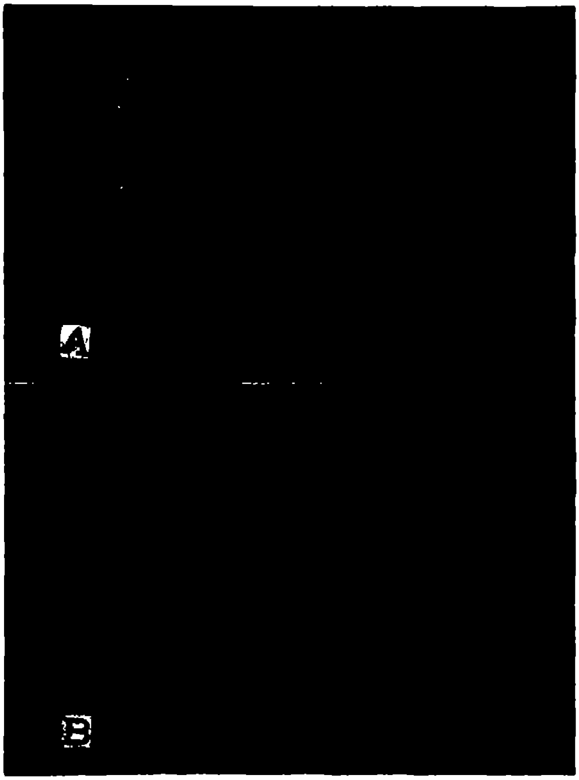

Fig 6 —A, Egg cord after deposition, ×1
B, Female hibernating among roots, ×1.

Eggs are regularly deposited in spring, but rare females occasionally were observed depositing in fall. Segmentation and larval development may occur immediately or be delayed for some months.

LIFE CYCLE OF GORDIUS ROBUSTUS IN THE ARROWROCK SECTION

Overwintering females emerge from their hibernating quarters in the loose gravelly soil or under sticks, stones, and rubbish (Fig. 6, B) during April and May and enter the shallow water of swamps, pools, or streams where the eggs are deposited Many of the eggs hatch soon after deposition, while others may remain for several months without hatching Some of these taken to Salt Lake City contained living larvae until September, and it is doubtful if they would have hatched that fall.

The minute larvae move slowly about in the water, frequently lifting themselves up on the tips of their tails and swinging about in circles. Here they apparently are picked up by the young crickets when drinking, or when eating aquatic plants, and pass to the intestine Presumably they force their way through the intestinal wall into the body cavity with the toothed proboscis while they cling to the intestinal tissues by means of the three rows of cephalic hooks

After entering the body cavity growth takes place so rapidly that by late in June many are full grown and ready to emerge from the crickets Apparently the time of leaving the host depends upon some sense of proximity to water, for during the heat of the day, when crickets congregate in the shade along streams or moist areas, the mature *Gordius* break through the abdominal wall and emerge, moving into the water or burying themselves in the moist soil.

At the time of emergence from the host the color of the females varies from a milky white to light brown, and that of the males from light to dark brown After exposure to light the color deepens, especially in the males, which are usually darker than the females, sometimes almost black

Copulation takes place in the water, perhaps also in the soil, soon after emergence Females collected July 26 usually contained sperms in the uterus

Larvae—The larvae (Fig 5, D) range in length from 0.12 to 0 16 mm and average about one-ninth as wide as long. The flexible cuticle is marked by annules that vary in distinctness and width as the individual moves about The broad anterior end bears three circlets of cephalic hooks, the second row is arranged directly behind the first, while the third row alternates, the hooks being back of the interspaces of the first two rows When at rest these hooks are retracted into the oral opening until the last row points almost straight forward As the proboscis is extruded the hooks roll out and back (Fig 5, E)

The slightly clavate proboscis bears two or three very minute projections on its distal end Back of these, on the anterior conoid portion, are about six rows of fine corrugations The proboscis joins the tubular esophagus, their combined length varying from one-eighth to two-fifths that of the entire body

The larvae generally have a pointed tail, but occasional specimens had blunt, rounded tails (Fig. 5, F).

The larvae are soft bodied and unable to withstand drying Exposure to air on a bamboo splinter for one minute was fatal in every case.

The manner in which the larvae of *Gordius robustus* enter *Anabrus simplex* was determined by the following method: A supply of crickets was secured near Tooele, Utah, where *G. robustus* is not known to occur. Lettuce was fed to the crickets, and as soon as one was busily feeding a drop of water containing several larvae of *G. robustus* was placed just in front of it Generally the cricket continued feeding and swallowed the larvae along with the food.

Thirty crickets were fed in this manner on June 15 to 18 and placed in a cage A few crickets were removed each week thereafter, three to five at a time, and dissected On July 1, one female contained a male *Gordius* 260 mm long and on July 9 another female was found with a male *Gordius* 245 mm long. Of the 30 crickets, 18 died and 12 were dissected Only the two mentioned were parasitized

At the same time 23 crickets were selected, and a drop of water containing several larval *Gordius* was placed in the folds between the sclerites of the abdomen. Of these 23 crickets, 9 died and the remainder were dissected, none being found infested Because of their sensitiveness to drying it would appear impossible for the larvae to enter the body of the host in any manner other than through the mouth

Unfortunately the season was so far advanced that very young crickets could not be secured, and those used in the above experiments were all in the second and third instars In these large crickets the larval *Gordius* apparently are carried through the intestinal tract before they have an opportunity to penetrate the intestinal wall This appeared to be proved by the fact that among 50 adult crickets confined in wet swampy pens, in which thousands of *Gordius* eggs and larvae were kept in excellent condition, not one became parasitized An abundance of small aquatic plants was present and these, together with the water consumed, certainly would appear to have given every cricket ample opportunity to become parasitized.

ECOLOGICAL FACTORS

In the postparasitic stages *Gordius robustus* thrives best in warm shallow pools with loose gravelly banks well covered with vegetation These conditions enable them to congregate during the mating season and later work their way into the loose soil, under stones and sticks, or into masses of roots or leaves, where they hibernate during winter. Seep areas where warm ground water rises during winter are especially favorable, and in the Arrowrock Dam section these areas were generally inhabited by large numbers.

In the years preceding these investigations such conditions had prevailed in the Arrowrock section There had been no unusual runoff and the stream beds were littered with sticks, pieces of logs, and loose stones, making ideal breeding conditions for *Gordius robustus* (Fig. 7, A)

The months of January and February, 1936, were unusually cold, each with average mean temperatures of 23 4° F , 1.7° and 7.4° respectively below the normal at the Arrowrock Reservoir station. This temperature was accompanied by a heavy snowfall with a water content of 10.14 inches, 4 87 inches above the mean for these two months As a result the loosely packed snow melted rapidly during March and especially during April. Streams flooded over their banks, channels were widened and deepened, and all

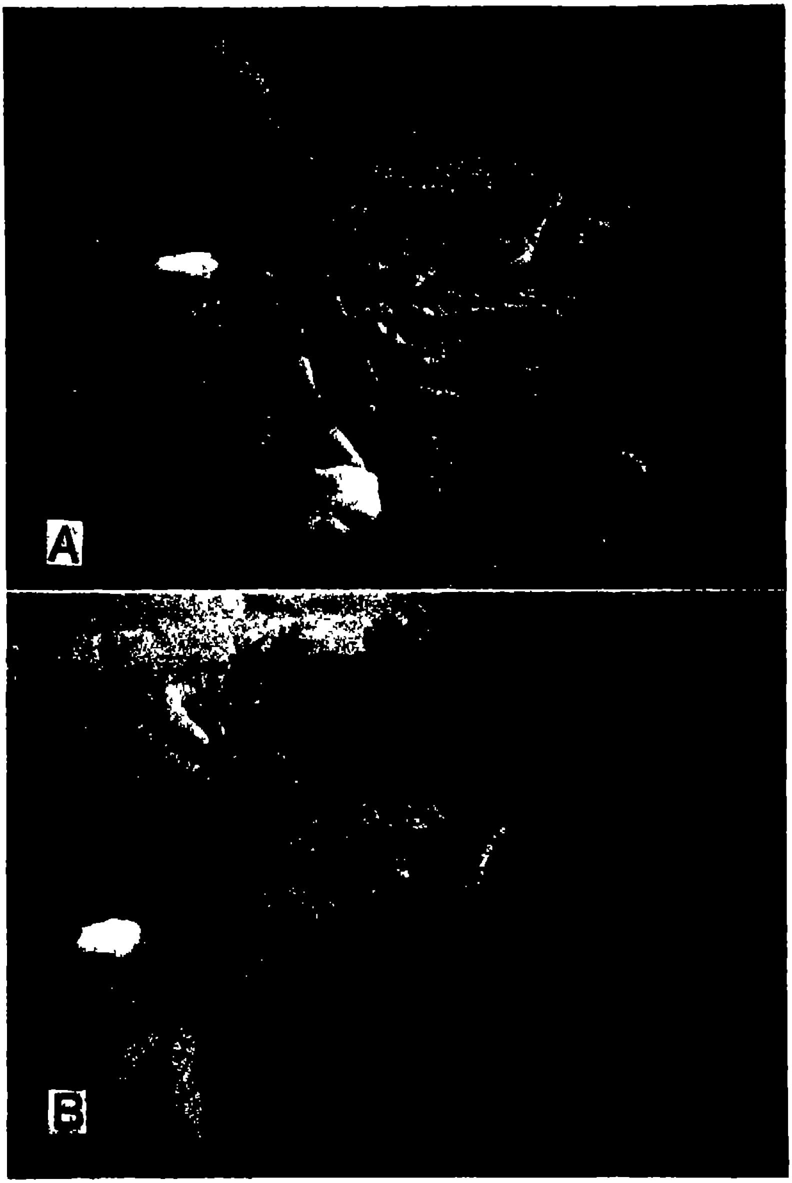

Fig 7.—A, Upper Elk Creek, Idaho, July 26, 1935
B, Same location, May 16, 1936.

debris was removed (Fig. 7, B). Most of the hairworms that had hibernated in the stream channels and adjacent banks were carried away by these floods. Scores of them could be found hanging high on limbs and roots where they had been left as the waters receded. As a result the *Gordius* population in the Elk Creek and neighboring basins was estimated to be only 5 to 10 percent as great as in the preceding year Many years will be required to repair the erosion damage to these stream beds and return them to their former conditions, which were so favorable as breeding grounds for *Gordius*.

SUMMARY

The hairworm *Gordius robustus* was first observed as an important parasite of the Mormon cricket, *Anabrus simplex*, in 1935 in the vicinity of Arrowrock Reservoir, Idaho. In certain localities of this area there are favorable breeding grounds for the hairworm along small mountain streams and in pools or swamps. In these localities they may be of economic importance in the control of ordinary populations of Mormon crickets. However, during heavy outbreaks of crickets, such as occurred in 1935 to 1937, the percentage of parasitism was too small to be of economic importance, although in some instances it reached 25 to 50 percent of the crickets Similar parasitism was also observed near Augusta and Cutbank, Mont , where in certain small areas 50 to 99 percent of the crickets contained Gordii

Parasitized crickets rarely produce eggs. They live normally until the mature *Gordius* breaks through the abdominal wall and enters water or wet soil Here the Gordii mate and later hibernate in moist places under sticks and stones or among roots and rubbish Some eggs are deposited in fall but more generally in spring, when the females emerge from hibernation and deposit them along the shores of streams, ponds, or swampy areas. Here the minute larvae hatch and probably are picked up by the young crickets when drinking water or eating aquatic vegetation. Upon reaching the intestine of the cricket they apparently bore through the wall and enter the body cavity, remaining there until maturity

Under present erosion conditions in breeding areas of the *Gordius* most of them are carried away by floods.

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SCIENTIFIC NOTES AND NEWS

CONFERENCE ON A NEW FLORA OF THE DISTRICT OF COLUMBIA

A conference on a new flora of the District of Columbia (to replace the one published in 1919) was held at George Washington University, February 20, 1940.

An Executive Committee was appointed to administer the venture. The chairman of this committee is E H. WALKER, of the U. S National Herbarium, and the other members are C R BALL, Extension Service, U. S. Department of Agriculture, AGNES CHASE, Smithsonian Institution; ROBERT F GRIGGS, George Washington University, NEIL HOTCHKISS, U. S Biological Survey; and HUGH O'NEILL, Catholic University.

The conference discussed the area to be included in the new flora, and though no final decision was taken it was the consensus that the limits be extended beyond those established for the current flora It will be several years before the new flora goes to press, and the intervening period will be utilized in collecting The George Washington University has provided space, with tables and storage cases, in which several botanists have offered to deposit their local collection

All those desirous of participating in this enterprise should communicate with E H WALKER

Obituary

FREDERICK GALE TRYON, economist, National Bituminous Coal Commission, died on February 15, 1940 Mr Tryon was born in Minneapolis, Minn , in 1892. He was graduated from the University of Minnesota with an A.B. in 1914, and in 1916 he received his A.M degree from that institution Later he did additional graduate work at Johns Hopkins University In 1916 and 1917 he was employed as an assistant geologist with the Empire Gas & Fuel Co During the Great War he was commissioned as a captain and assigned to the statistics branch of the General Staff of the Army in Washington and with G H Q in France, and later was American secretary for the raw materials section, Supreme Economic Council, American Peace Commission, Paris, 1919 In 1920 to 1925 he served as a mineral geographer in charge of coal and coke statistics for the U S Geological Survey During a part of this time, from 1922 to 1923, he further acted as statistical adviser to the U. S. Coal Commission From 1925 to 1937 he was connected with the U. S. Bureau of Mines in fuel industries, during 1936 and 1937 as principal economist. In 1937 he was appointed economist in the Bureau of Research and Statistics, National Bituminous Coal Commission.

Mr. Tryon served on the staff of various institutions including the University of Pennsylvania, Brookings Institution, American University, and the Institute of Economics (Washington, D C.). He was appointed on the President's Research Committee to study social trends in 1932–1933, and in 1934–1935 to study population redistribution.

In addition to the Washington Academy of Sciences Mr. Tryon was a member of the Economics Association, the American Institute of Mining and Metallurgical Engineers, the Mining and Metallurgical Society, the Geological Society of Washington, and the American Association for the Advancement of Sciences and was a fellow of the Statistical Association.

JOURNAL
OF THE
WASHINGTON ACADEMY OF SCIENCES
VOL. 30 JUNE 15, 1940 No. 6

CHEMISTRY.—*A study of the association of magnesia with silica in a pure magnesium clay.*[1] P. G. NUTTING, U. S. Geological Survey.

A white clay occurring near Hector, Calif., described by Foshag and Woodford (1) was shown to be a nearly pure magnesium silicate of the montmorillonite type. It swells largely and disperses readily in water like the familiar Wyoming bentonites. Although composed almost entirely of a crystalline mineral, it is remarkable in that its magnesium may be completely removed (leaving pure silica) by electrodialysis. In view of this ready separation by electrical means, it seemed desirable to make solution analyses of this clay by the method previously described by the author. This method consists essentially of bringing the clay to equilibrium with various hot dilute solutions of acid or alkali and analyzing the resulting solution (2, 3). To clarify the interpretation of these analyses, pH determinations were made on each solution. Some rather remarkable results appear worth putting on record.

The magnesium is not removable by electrodialysis from a pure montmorillonite to any observable extent. From the Wyoming bentonites only the alkalies are thus removable. The swelling property of the Hector clay is doubtless due to its being saturated with alkali to base-exchange capacity, a property that, as shown by Mattson (4), is true for clays and soils in general. Alkali in the Hector clay amounts to 4.19 percent, of which 3.00 percent is Na_2O and 1.12 percent is Li_2O (1). Magnesium can not be exchanged for lithium or the lithium for magnesium, so that the exchangeable base is the 3.00 percent of Na_2O. The $1H_2O$ of water of crystallization is very firmly held, being released only above 650° C. (nearly 100° higher than in pure montmorillonite) and is completely removed only by heating to 1,000° C. Boiling with ammonium oxalate separates magnesium from silica as do of course the mineral acids. Sodium carbonate solutions remove the silica from the magnesium.

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The white Hector clay forms a permanent hydrogel in water, but the light-brown clay associated with it does not and may be readily separated by settling and decantation. The stock suspension used contained 8 grams per liter. To 100-cc portions of this stock in pyrex flasks was added hydrochloric acid to make concentrations ranging from 0.01 to 4.00 percent, as shown in Table 1. The flasks were kept at 90°–92° C. for 24 hours, the clay filtered out with Whatman 42 filter paper, the filtrate evaporated, dried at 160° C., and weighed in pyrex beakers. The residue consisted partly of water-soluble chlorides. These were removed by boiling in water. The water-insoluble residue, after drying and weighing, was treated for 20 minutes with concentrated hydrochloric acid to separate bases and silica, and these were determined. Calcium, iron, and aluminum were negligibly small. Magnesium was determined as pyrophosphate. The pH determinations were made with a glass electrode apparatus on portions of the filtrate carefully brought to room temperature (29° ± 1°). The intermediate range of concentrations (0.063 to 0.63 percent) were repeated six times since in this range equilibrium is extremely sensitive to operating conditions.

The more significant results are given in the following table and are graphed in the figure.

TABLE 1.—SOLUBILITY OF HECTOR CLAY IN HCl SOLUTIONS AND pH OF VARIOUS CLAY SOLUTIONS

Initial HCl Percent	In solution Grams per liter			Initial acid pH	Filtrate pH			m e q HCl per gm clay
	SiO_2	MgO Insoluble[1]	MgO Soluble[1]		Hector	Paris	Wyoming	
0 0	0 082	0 00	0 00	(0 01) 2 70	8 65	5 67	4 10	0 274
0 010	0 010	0 00	0 00	2 40	7 83	4 52	3 39	0 436
0 025	0 048	0 032	0 00	2 28	7 00	3 40	2 75	0.690
0 040	0 121	0 099	0 00	2 09	6 20	2 51	2 27	1 10
0 063	0 225	0 162	0 12	1 88	5 40	2 08	1 90	1 73
0 100	0 276	0 190	0 32	1 70	5 60	1.80	1 63	2 74
0 159	0 246	0 168	0 62	1 49	4 48	1 39	1 40	4 36
0 252	0 182	0 140	0 98	1 30	4 38	1 10	1 21	6 90
0 40	0 431	0 295	1 39	1.12	3 22	0.07	1 04	10 96
0 63	0 495	0 302	1 78	0 95	1 39	0 88	0 92	17 3
1 00	0 508	0 282	1 93	0 78	1 01	0 80	0 81	27 4
1 59	0 496	0 252	1 98	Fresh	9 90	9 52	9 55	(In H_2O
2 52	0 473	0.216	2 00	Cooked	—	9 10	—	only)
4 00	0 439	0 175	2 00	—	—	—	—	—

[1] After heating at 160° C.

The solubility of the Hector clay is of the same general character as that previously found (3) for the familiar Wyoming swelling bentonite. The reversal in slope in the concentration range of 0.1 to 0.25

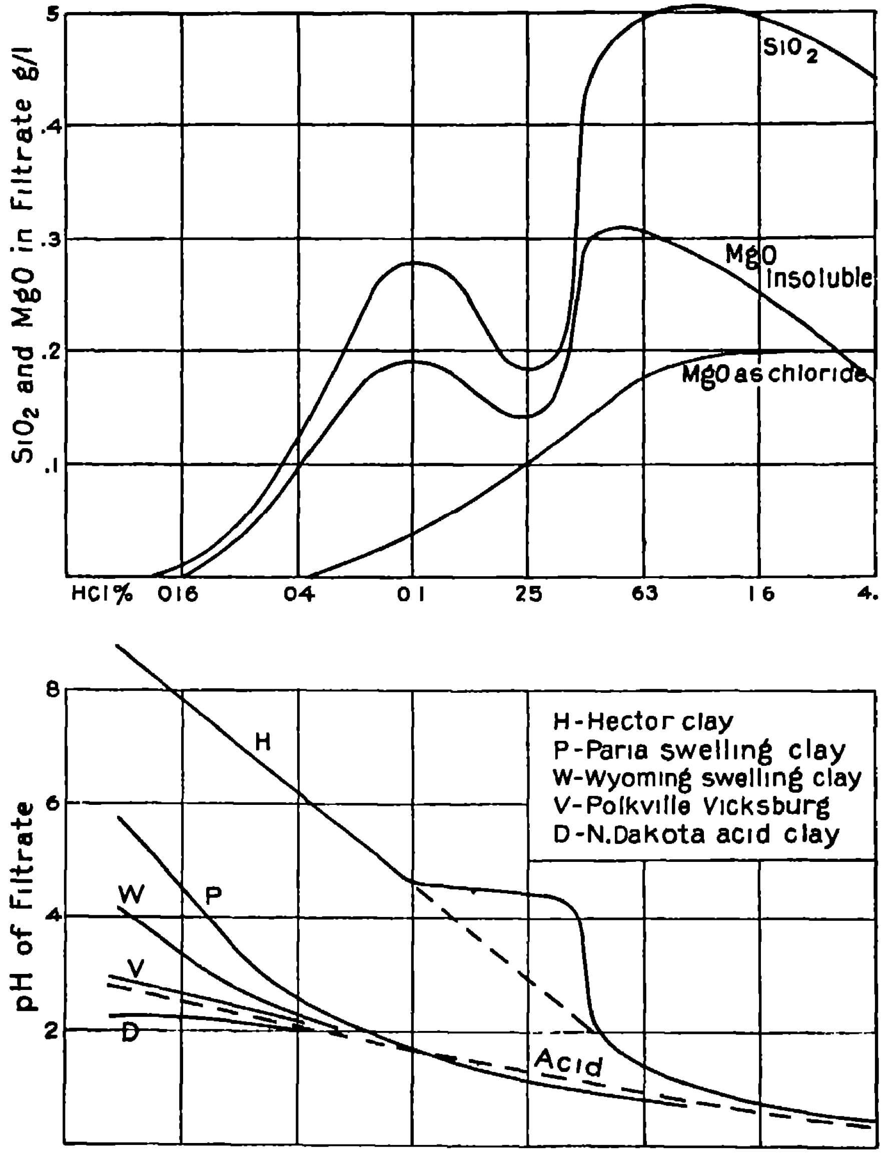

Fig 1 —Solubilities and pH values for Hector clay

percent acid occurs also in the curves for Wyoming bentonite in the range of 0.4 to 1.0 percent—four times the concentration. This reversal has been found in the nonswelling adsorbent clays low in sodium (2), but it can not be fully explained.

In pure water silica appears to dissolve as sodium silicate and the solubility (0.082 gm/liter) is higher than in dilute acid. It is nearly or quite insoluble in 0.01 percent acid but is rising rapidly at 0.04 percent reaching a first maximum at 0.1 percent. Magnesium, in a form insoluble in water (after evaporation to 160° C.), appears with about 0.016 percent acid and closely parallels the silica curve, the ratio of MgO to SiO_2 remaining about 0.7 throughout the entire middle range. In the clay that ratio is 0.5. Mg as water-soluble chloride appears in the filtrate residue at about 0.04 percent acid and steadily increases to a constant amount (0.2 gm/liter) above 1 percent acid, owing to the limited amount of clay present.

The pH curve of the equilibrium clay-acid filtrates descends from the initial value 9.9 for clay in pure water in a linear relation from 0.01 to 0.1 percent acid, then remains nearly constant from 0.1 to 0.4 percent, drops suddenly to the normal value, and continues just above the curve for pure acid (dashed line). The slope on the 0.1 to 0.4 percent shoulder is *less* than that for the acid solution alone; trebling the acid content lowers the pH only from 4.6 to 4.4. Such an effect might be produced by adsorption, as pH is a measure of the hydrogen ion activity, but the total magnesium going into solution is steadily increasing in that range. Living bodies maintain a similar constant pH regardless of the intake, possibly for a similar reason.

The pH curve for the Wyoming swelling bentonite lies very much lower than that for the Hector clay and exhibits a barely perceptible shoulder in the critical region. Three other swelling bentonites from Ontario, Oreg., Como, Colo., and Paria Valley, Utah, were investigated. The Paria clay runs higher than the Wyoming, the others are lower. For comparison pH runs were made on a Vicksburg bentonite, a very pure montmorillonite. The curve for this was almost identical with that for the acid solution, despite the fact that it is attacked by acid as freely as the Hector clay (2). Florida fuller's earth gave a pH curve almost identical with that for the Wyoming bentonite. An acid clay from northeastern North Dakota and a field soil gave curves slightly lower than that for straight acid. Not one of these clays, except the Hector, showed more than a slight irregularity in its pH curve where the Hector clay has a pronounced shoulder. At higher acid concentrations, the Paria clay curve dips well under the curve for pure acid as though an excess of silicic acid were released.

Summary.—The white swelling Hector clay breaks down in hot acid solutions like the swelling Wyoming bentonite but at markedly lower acid concentrations. The pH curve of the filtrates from these suspensions not only runs much higher than that of any of the seven other clays tested but exhibits a proncunced shoulder in an intermediate acid range not shown by the others. This shoulder indicates that hydrogen ions are inactivated either by physical adsoprtion or by chemical reaction, or that hydroxyl ions are released largely over a particular range.

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3 ———*The action of some aqueous solutions on clays of the montmorillonite group* U S. Geol Surv Prof Paper (Not yet published)
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PHYTOCHEMISTRY.—*Some new cyanogenetic plants.*[1] E. A. MORAN, R. R. BRIESE, and J. F. COUCH, U. S. Bureau of Animal Industry.

This paper reports the detection of hydrocyanic acid or of compounds capable of developing it in six species of plants not hitherto known to be cyanogenetic together with some figures for the HCN content of *Triglochin palustris.*

Emplectocladus fasciculatus Torr.—California desert almond, one of the Amygdalaceae, is found in California, southern Nevada, southern Utah, and Arizona, according to Tidestrom.[2] It is a small spinescent shrub closely related to the well-known cyanogenetic genus *Prunus.* It has not hitherto been reported as being cyanogenetic. Material was collected in 1936 in Wah Wah Valley, 30 miles west of Milford, Utah. This was dried and shipped to Washington. Analysis of the leaves showed a high HCN content of 172 mg per 100 g. Leaves collected on June 19, 1937, at 2 P.M. in the same locality were preserved in 1 percent mercuric chloride solution. Analysis of these samples at 4, 8, and 12 weeks after collection gave 132, 135, and 134 mg HCN per 100 g green. Neither acetone nor benzaldehyde could be detected in the distillates from these samples, and no clue was obtained as to the nature of the cyanogenetic glucoside.

Linum kingii S. Wats.—A perennial yellow-flowered flax found in Wyoming and Utah, according to Tidestrom, belongs to a recognized cyanogenetic genus. The common flax, *Linum usitatissimum,* is a well-known cyanogenetic species,[3] and several cases of poisoning of livestock have been traced to it. Fresh material was collected on

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[1] Received January 3, 1940.
[2] TIDESTROM, IVAR *Flora of Utah and Nevada* Contr U S Nat. Herbarium 25 1925.
[3] JORISSEN and HAIRS Bull Acad Roy Belg (3) 21: 529–540 1891

July 13, 1938, from the mountain sides near the Salina (Utah) Experiment Station of the U. S. Bureau of Animal Industry and at an altitude of 7,800 feet. The plants were then beginning to blossom. The fresh material was preserved in 1 percent mercuric chloride solution and shipped to Washington. On analysis after one month the sample gave 0.98 mg HCN per 100 g of plant. A sample preserved in water alone gave 1.07 mg under the same circumstances. This species is, therefore, only slightly cyanogenetic in the flowering stage.

Linum lewisii Pursh.—Prairie flax. A perennial blue-flowered species found, according to Tidestrom, from Manitoba to Alaska, southward to Texas, California, and Mexico. Fresh material of this species was collected on June 24, 1938, from a locality 10 miles southeast of Salina, Utah, at about 6,000 feet altitude. The fresh plant preserved in 2 percent mercuric chloride was shipped to Washington. The plants were in late-blossom and immature fruit stage of growth. Analysis after 2 months showed 69 mg HCN per 100 g or considerably more than *L. kingii* contained. If grazed by cattle or sheep, *L. lewisii* is likely to produce fatal poisoning.

Glyceria septentrionalis Hitchc.—The cyanogenetic properties of eastern mannagrass were discovered by George B. Reynard, of the U. S. Bureau of Plant Industry, who collected samples at Oakland, Md., on September 4, 1937. Mr. Reynard stated that the fresh grass gave a strong Guignard test for HCN. A partly dried sample that he submitted to the authors was identified by Mrs. Agnes Chase. On analysis it gave 30.9 mg of HCN per 100 g. Several other species of *Glyceria* have previously been reported to be cyanogenetic.[4] At the level of HCN found in the specimen *G. septentrionalis* should be dangerous to ruminants if eaten in quantity.

Centaurea americana Nutt.—Basket flower, American star thistle. Seeds of this plant were submitted by Robert Merz, Jr., of College Station, Tex. Hydrocyanic acid has been reported from the following species: *C. montana* and *C. solstitialis* by Couperot[5] and from *C. crocodylium* by Mirande.[5] The seed of *C. americana* gave 5.8 mg. of HCN per 100 g.

Stillingia dentata (Torr.) Britton and Brown. Dried plants collected by O. G. Babcock in the vicinity of Garden City, Tex., were supplied by Dr. H. L. Haller, of the U. S. Bureau of Entomology and Plant Quarantine. Mr. Babcock stated that the plant was very poisonous to sheep and that the circumstances of the poisoning indicated the possibility of cyanogenetic glucosides and alkaloid being present. Analysis of the dry leaves and stems showed that 77.7 mg. of HCN per 100 g could be obtained after 24 hours of maceration in water. This method is known to give somewhat low results, and it may be concluded that the actual quantity potential in the dried plant is 10 to 20 percent higher than the figure stated. The quantity of material at hand was insufficient to permit further investigation of this point. At this level of HCN it can be said that this plant is very dangerous to cattle and sheep.

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[4] Cf. WEHMER, C *Die Pflanzenstoffe*, Jena, 1929, Ergänzungsband, 1935; and ALSBERG, C., and BLACK, O F. Journ Biol Chem 21:601-609. 1915

[5] WEHMER, C *Loc cit*

Triglochin palustris L.—Arrowgrass has been reported cyanogenetic[6] but much less is known about this species than the more important *T. maritima*, and no figures for its HCN content have been published. Material of *T. palustris* collected by J. H. Ehlers at Cheboygan, Mich., in August 1938 and dried was analyzed September 20. It gave 13.5 mg HCN per 100 g. The plant had flowered but was not yet in seed. The quantity of HCN found is considerably smaller than is customarily given by *T. maritima* dried samples of which commonly yield more than 100 mg of HCN per 100 g, and specimens running from 200 to 300 mg are not uncommon. One specimen growing under water contained only 13.4 mg calculated on the basis of fresh plant.

GEOLOGY.—*New formation names to be used in the Kingston Range, Ivanpah quadrangle, California.*[1] D. F. HEWETT, U. S. Geological Survey.

A thick series of sedimentary rocks of late pre-Cambrian age that occur in the Kingston Range have not heretofore been divided into mappable units. They have been referred to in adjacent regions by previous writers[2] as Algonkian strata. The series comprises about 6,500 feet of sandstone, conglomerate, quartzite, shale, and dolomite that crop out on the north and east slopes of the Kingston Range. They are somewhat similar to a series of rocks that occur in the Grand Canyon region of Arizona. This assemblage of sedimentary rocks in the Kingston Range is named the Pahrump series, from a nearby valley lying north and northeast of the Kingston Range. It rests unconformably on pre-Cambrian granite gneiss and is overlain unconformably by sedimentary rocks that probably represent the basal formation of the

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[6] GRESHOFF, M Pharm Weekbl **45**: 1105–1109 1908; BLANKSMA, *ibid* **50**: 1295–1302 1913

[1] Published by permission of the Director, Geological Survey, U S Department of the Interior. Received March 23, 1940

[2] NOBLE, LEVI F. *Rock formations of Death Valley, Calif* Science, n s, **80** (2009) 173–178 1934. HAZZARD, JOHN C *Paleozoic section, Nopah and Resting Springs Mountains, Inyo County, Calif* Calif Journ Mines and Geology, State Mineralogist's Rept **33**(4) 288–339. 1938.

Paleozoic rocks, Lower Cambrian in age. The formations to be described are as follows:

Pahrump series	Kingston Peak formation
	Beck Spring dolomite.
	Crystal Spring formation

Crystal Spring formation.—This formation crops out in a belt that extends for 5 miles around the north slope of the Kingston Range and in two areas on the eastern slope of the range. The formation comprises about 2,000 feet of quartzite, arkose, shale, and limestone, intruded by sills of diorite and syenite, with beds of dolomite and chert at the top and thick coarse conglomerate at the base. The base of the formation has been observed at only one locality, on the west end of a ridge 2 miles east of Horse Spring. Here conglomeratic quartzite rests on pre-Cambrian gneissic granite. No fossils were found in the formation. The name of the formation is derived from Crystal Spring on the north slope of Kingston Range.

Beck Spring dolomite.—The Beck Spring dolomite conformably overlies the Crystal Spring formation and crops out conspicuously in a belt 6 miles long on the north slope of Kingston Range. Two smaller blocks of the dolomite, each about 1 mile long, crop out in the hills northeast and east of the range. The formation is made up largely of beds of light bluish-gray dolomite, 2 to 4 feet thick, separated by layers of shaly material, and is about 1,000 feet thick. No clearly identifiable fossils have been found in it, but layers of roundish concretions about half an inch in diameter, found at one place, may be of algal origin. Beds of oolite several feet thick are also numerous. The name of the formation is derived from Beck Spring on the north slope of the range.

Kingston Peak formation.—The Kingston Peak formation is an unusual assemblage of sediments that conformably overlie the Beck Spring dolomite. It crops out in a belt 20 miles long around the north and east slopes of Kingston Range but is interrupted by several faults. The formation is about 1,900 feet thick, along the western part of the belt, but at the east end it appears to be much greater. The formation consists of sandstone and limestone with a thick coarse conglomerate in the middle. The conglomerate is made up largely of subangular cobbles of limestone up to 12 inches in diameter with quartzite and granite cobble predominating near the base. This uncommon assemblage of sediments resembles the debris that forms fans on the border of the present valleys, called fanglomerate. The name of the formation is derived from Kingston Peak, the highest point in the range.

BOTANY. *Three fungi destructive to free-living terricolous nematodes.*[1] CHARLES DRECHSLER, U. S. Bureau of Plant Industry.

In several earlier papers (5, 6, 8, 9, 10) comparative treatment was accorded to 24 fungi that had been observed to subsist on free-living nematodes infesting old agar cultures started from diseased rootlets or from other decaying vegetable materials. As the agar media employed were of a concentration sufficient to insure a rather firm consistency together with relative freedom from liquid water, the cul-

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[1] Received December 6, 1939.

tures provided approximately terrestrial rather than aquatic conditions, and therefore not only encouraged the multiplication of eelworms mainly terrestrial with respect to source and adaptation, but also permitted development of the similarly terrestrial fungi habitually destructive to them under natural conditions. The 24 fungi hitherto treated include representatives of two distinct groups—21 species, mainly predaceous in mode of attack, being referable to an interrelated series of hyphomycetes wherein are embraced members of the genera *Arthrobotrys*, *Trichothecium*, *Dactylella*, *Dactylaria*, *Tripospormina*, and *Tridentaria*; the remaining 3 species being referable to the Zoopagaceae, a distinctive family of conidial phycomycetes mostly destructive to terricolous rhizopods.

Apart from recognizable members of the predaceous mucedinaceous series and of the Zoopagaceae, about a score of additional fungi have been observed to destroy free-living nematodes in agar cultures. Nearly all these forms are parasitic in their mode of attack, infecting their hosts by germination of adhering conidia. Only one among them, the widely distributed and very destructive *Harposporium anguillulae* Lohde, can with any certainty be referred to a species previously reported as parasitic on nematodes. This meager agreement with earlier findings is not surprising when it is considered that in large part the literature on fungus parasites of nematodes records observations made on animals kept under conditions widely different from those obtaining in agar cultures. The relevant contributions by Braun (3), Sorokine (23), Sadebeck (19), Dangeard (4), Lindner (13), Maupas (16), Micoletzky (17), and Sparrow (24, 25) dealt presumably with infections of actively motile eelworms that came about under conditions apparently more nearly aquatic than terrestrial. Baunacke (1), Goffart (11), Korab (12), and Rozsypal (18), on the other hand, were concerned with parasites destructive to the eggs and the almost equally inert larvae in cysts of *Heterodera schachtii* Schmidt. Now, manifestly, infection of active eelworms by fungus spores under aquatic conditions, and infection of inert stages under terrestrial conditions, are not attended by the difficulties usual in infection of actively motile eelworms under terrestrial conditions. For in their brisk movement through soil or through decaying organic materials, terricolous nematodes constantly tend to scrape away the spores adhering to them externally, much as cattle rid themselves of the larger stinging flies in walking through dense shrubbery. Small size, slender or flattened shape, and strong adhesiveness are among the physical attributes whereby the spores of successful parasites are enabled to withstand the adverse mechanical action to which they are exposed. In the two phycomycetous parasites herein described some of these attributes are derived from developmental modifications that appear to be of taxonomic significance.

Haptoglossa heterospora

A fungus evidently referable to one or another of the several zoospore-producing groups in the Phycomycetes has frequently been observed destroying enormous numbers of nematodes in agar cultures prepared from media of rather soft consistency and planted with decaying portions of roots or stems originating in greenhouse or field It has also been found destroying nematodes in agar cultures that after being permeated with *Pythium* mycelium had been further planted with pinches of leaf mold collected in deciduous woods in Virginia, Maryland, or Wisconsin Most of the species of eelworms commonly infesting soft agar cultures started from vegetable materials that have undergone partial decomposition in contact with moist ground, appear susceptible to attack by the fungus, though differences in the rapidity of their destruction are often noticeable The appearance of the fungus in a petri-dish culture leads usually within a few days to the extermination of all active individuals of the susceptible species present. In its spectacular destructiveness and widespread distribution the fungus invites comparison with *Harposporium anguillulae* and with the larger of the retiary predaceous hyphomycetes, particularly *Arthrobotrys oligospora* Fres., *A. conoides* Drechsl, *A musiformis* Drechsl, and *Dactylaria thaumasia* Drechsl

During the earlier stages of its development within a nematode the fungus is relatively inconspicuous At about the time the infected animal becomes incapable of further locomotion, the parasite may be discerned imbedded in the granular and globulose material resulting from degeneration of musculature and organs (Fig. 1, A) With further appropriation of the degenerating material it improves markedly in visibility and increases somewhat in volume (Fig 1, B), so that when the last remnant of digestible substance has been absorbed, it is revealed with much distinctness inside the otherwise empty host integument (Fig 1, C–G).

In an individual host animal the parasite may be represented by a single thallus (Fig 1, F) or by many thalli (Fig. 1, A–E, G) Instances of infection by a single thallus or by two or three thalli are especially frequent early in the course of an epizootic As the epizootic continues the number of thalli in the individual infected eelworm increases rapidly, with the result that in the end instances of infection by more than 50 (Fig. 1, C) or even more than 100 thalli are not infrequent. This increase in number, naturally, is accompanied by proportional decrease in size, and, somewhat secondarily, by some change in shape; the larger vegetative bodies being generally of cylindrical conformation, with bluntly rounded ends, whereas the smaller specimens are mostly of prolate ellipsoidal conformation. Irregular modifications of outward form, such as median constrictions and narrowed terminal prolongations, occur here and there. The larger vegetative bodies are frequently somewhat curved or crooked, either because of crowding by their fellows (Fig. 1, B, G), or because of constraint from the posture taken by the host animal in its death (Fig 1, F).

Following exhaustion of their food supply the thalli of the fungus are transformed into sporangia. The smaller specimens (Fig 1, I, J, K) each put forth laterally a single broad protrusion that presses the animal's integument outward in a perceptible bulge. More or less simultaneously cleavage lines appear in the granular protoplasmic contents, dividing them into units of approximately equal volume Suddenly the broadly rounded tip of the protrusion yields, and the delimited protoplasmic lumps are in large part forcibly expelled through the opening Transformation of the larger thalli usually entails development of several protuberances at some distance from one another. In instances where five or six beaks are formed, two or three of them may participate in dehiscence Regardless of the number of openings present, a considerable proportion of the protoplasmic lumps usually fail to be discharged (Fig 1, H, *b*, *c*, L, O), and must await their liberation by the disintegration of host integument and sporangial membrane

After being propelled some distance into the adjacent medium, the discharged protoplasts round up individually to form irregularly globose immotile spores (Fig 1, H, *c*; L) Each of the encysted bodies soon gives rise to a bud, which then grows out (Fig 1, Q) to form eventually a flattened structure with an elongated lateral lobe that is usually curled at its tip in a tonguelike manner (Fig 1, M). Often the axial or proximal portion of the flattened structure, like the envelope of the immotile spore to which it remains attached, is found evacuated of contents, all of the protoplasmic material having been collected in the glossoid lobe Before long, hundreds of the curiously constituted units thus resulting from asexual reproduction surround the integumentary remains of each host animal like a dense cloud

When a healthy nematode passes through such a cloudlike array, some of the reproductive bodies become fixed to it, attachment being accomplished apparently through adhesion of the concave surface of the glossoid lobe to the animal's integument. Upon perforation of the integument by a minute opening the protoplasmic contents of the reproductive body migrate inward to form a small saclike structure This structure then proceeds to develop autonomously, thereby again giving rise to a cylindrical or ellipsoidal thallus.

During the later and more readily discernible stages in their development some of the thalli can be seen attached to the animal's integument by a conical connection devoid of protoplasmic contents (Fig 1, G). In this conical part is to be recognized unquestionably the saccate body by which invasion was initiated The larger number of thalli, however, show no evident connection to the integument, a circumstance that might imply either that thalli often multiply by division, or that connections originally present often are destroyed as a result of movement by the animal An approximate end-to-end arrangement of thalli (Fig. 1, A, B) occasionally to be observed argues somewhat in favor of the former alternative, while the latter is supported more especially by the frequent absence of any observable connection between integument and fungus in animals parasitized by only a single thallus (Fig. 1, F). Since such single thalli, when occurring in large animals, attain impressively large dimensions without dividing into units of smaller size, it may be presumed that vegetative division is at least not a constant feature in the development of the fungus The presence of very numerous thalli in infected animals during the later stages of an epizootic in an agar culture is very obviously attributable to the enormous numbers of germinated spores then distributed through the medium. Often in such later stages the incipient infections from individual spores are so numerous and close together that the intruding protoplasts, operating virtually as a mass, will extensively separate integument from naked musculature. In the head region, especially, such wholly pathological separation—not to be confused with hastened

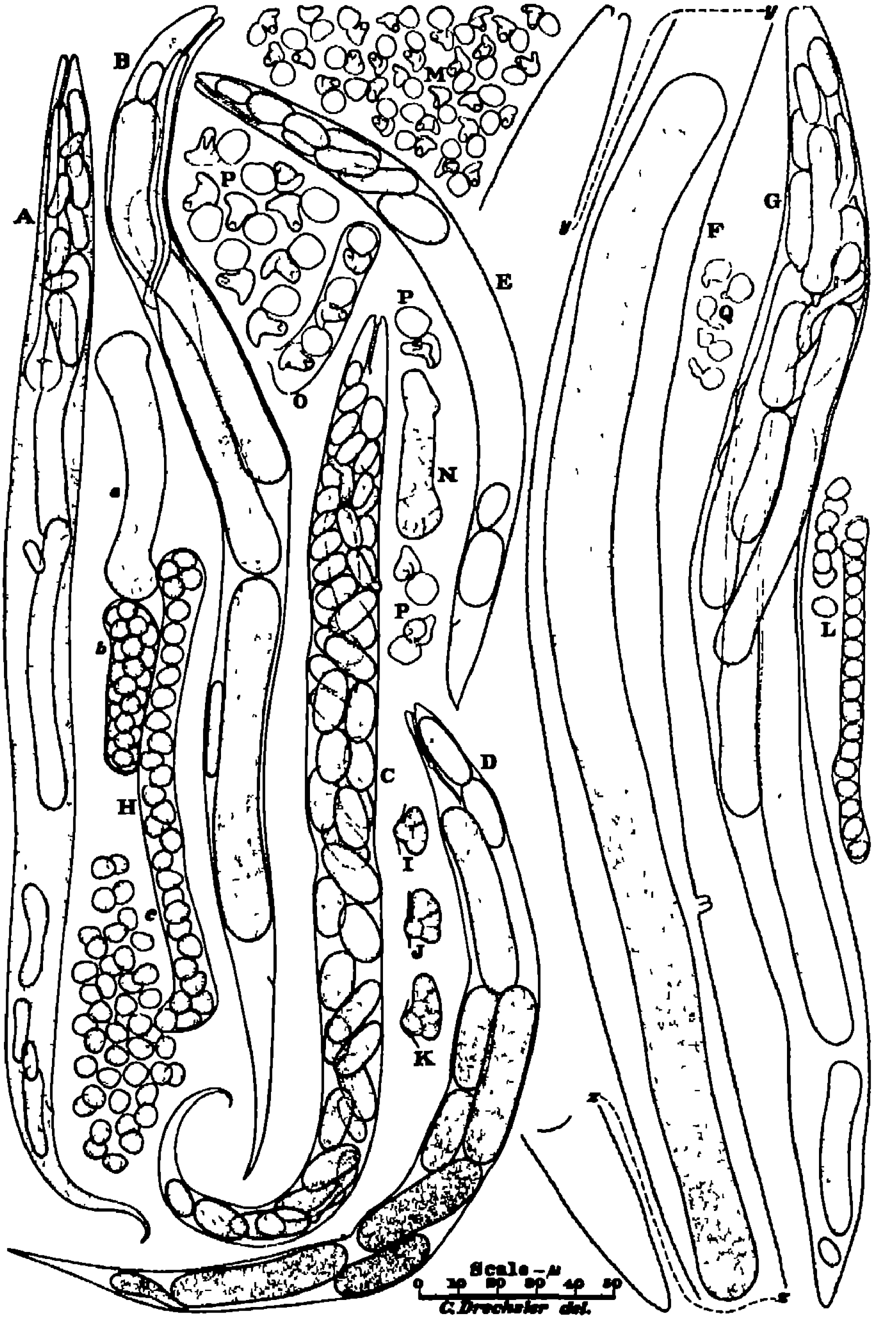

Fig 1 —(See opposite page for explanation)

molting—is often associated with conspicuous deformation of fleshy structures.

With respect to size the immotile spores from each individual sporangium show only moderate variation. Most frequently, perhaps, they range in diameter between 4.5 and 6μ (Fig. 1, H, *b*, *c*, L, M). Many sporangia, however, give rise to spores ranging in diameter between 8 and 10μ (Fig. 1, N; O; P). It is not apparent that spores of intermediate dimensions are produced except as unusually oversized specimens in clusters referable to one category, or as undersized specimens in clusters referable to the other category. As sporangia producing the larger spores frequently occur in the same host animal with sporangia producing the smaller spores, the difference in dimensions can not readily be held traceable to differences in environmental conditions. Unstained living material reveals no divergence in manner of development or in mode of infection associated with the inequality of size.

Presumably the production of flattened lobate or glossoid infective structures by the discharged immotile sporangiospores represents a developmental process equivalent to the emission of motile zoospores from encysted sporangiospores familiar in the saprolegniaceous genera *Achlya* and *Aphanomyces*. Certainly, the type of asexual reproduction concerned here shows less similarity to the *Pythium*-like reproduction that is found associated with more or less swollen endoparasitic thalli in the genera *Lagena*, *Lagenidium*, and *Myzocytium*, than to the *Achlya*-like reproduction associated with swollen endoparasitic thalli in *Ectrogella* and *Aphanomycopsis*, as these genera were understood by Scherffel (21). With *Ectrogella* and *Aphanomycopsis*, moreover, the fungus under consideration offers further morphological parallelism in the pronouncedly grandular consistency of the protoplasm in its thalli—a consistency which Scherffel held with some justification to distinguish the Saprolegniaceae and Peronosporales from the Ancylistales and Chytridiales.

In its curious emission of immotile infective structures from immotile sporangiospores the fungus would seem to provide a plausible transition between the *Achlya*-like diplanetism of *Ectrogella* and *Aphanomycopsis*, on the one hand, and the direct discharge of immotile infective sporangiospores in *Protascus subuliformis* Dangeard (4), a parasite destructive to nematodes, on the other. The existence of such a transitional type of asexual reproduction lends support to Maupas (16) and Maire (14) in their interpretation of the conical sporangiospores of *P. subuliformis* as bodies homologous to motile

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Fig. 1.—*Haptoglossa heterospora*, drawn to a uniform magnification with the aid of a camera lucida, × 500 throughout. A, B, C, D, Nematodes probably referable to *Rhabditis dolichura* Schneider, containing respectively 16, 5, 54, and 10 thalli of the fungus. E, Nematode, referable to *Cephalobus* sp., containing 10 thalli of the fungus. F, G, Specimens of *Acrobeloides bütschlii* (De Man) Thorne occupied respectively by 1 and 18 thalli of the fungus; owing to lack of space F is shown in three parts, which connect at the points *y* and *z*. H, Three neighboring thalli: *a*, in an early stage of transformation into a sporangium, showing two papillae of dehiscence; *b*, a sporangium, partly evacuated, within which the numerous retained spores have encysted; *c*, a sporangium showing in profile a papillar orifice through which many zoospores have been discharged, though a large number, too, have encysted within. I, J, K, Three small sporangia, each showing a papilla of dehiscence some little time previous to discharge of spores. L, Sporangium after partial emission of spores. M, Discharged spores of the usual smaller size, each of which has given rise to a lobate infective body. N, Sporangium with two papillae of dehiscence; its contents showing demarcation into spores of the larger size. O, Sporangium within which three spores of the larger size have germinated to form infective bodies. P, Spores of the larger size, each with an infective body attached to it. Q, Spores of the smaller size, showing different stages in the emission of infective bodies.

zoospores of the aquatic phycomycetes. Indeed, the transitional type of sporangiospore development herein set forth may have been known to these authors, as Maupas took occasion to allude to "les spores, également immobiles, de mon *Ectrogella?* sp." I have not found any published account of the form to which this allusion applied, yet as it is recorded by his obituarist (22) that Maupas worked rather extensively on fungi parasitic on nematodes, the doubtful *Ectrogella* species may have been encountered as a parasite on eelworms, and may therefore have been a fungus related to, or perhaps even identical with, the one under discussion.

Achlyogeton entophytum Schenk and *A. rostratum* Sor., both reported by Sorokine (23) as being parasitic on nematodes, differ from my fungus in that their thalli become partitioned into somewhat distended segments, which, though functioning individually as sporangia, remain connected with one another. In their development the zoospores of *A. entophytum* reveal an *Achlya*-like diplanetism, except for the difference, if Schenk's account (20) is to be trusted, that the motile stage is uniciliate rather than biciliate. While Schenk's representations relative to the number of cilia are so much at variance with expectations that their correctness has been questioned, the observations of Martin (15) and Tokunaga (26) have corroborated the existence of a secondary motile stage, and it seems certain, at least, that in *A. entophytum* the zoospore protoplast does not remain attached to the empty cyst envelope as an immotile infective body.

Erection of a new genus, under a name compounded of two words meaning "to fasten" and "tongue," is made necessary by the curious development of the sporangiospores in the present fungus.

Haptoglossa gen. nov.

Thalli singuli vel complures in viva animalia crescentes, elongato-cylindrati vel elliptici, maturitate protoplasmatis dense granulosi repleti, omnino sporangia evadentes; sporangio uno vel aliquot tubis papillisve mox instructo, sporas inertes expellente, sporis inertibus a vesicula non circumdatis, quisque corpus planum inertem inficiens proferente.

Vegetative thalli elongate-cylindrical or ellipsoid in shape, developing singly or in variable numbers within living animals, at maturity filled with densely granular protoplasm and in their entirety becoming converted into sporangia, the individual sporangium provided with one or several evacuation tubes or evacuation papillae, through which ready-fashioned spores are forcibly expelled without formation of any enveloping vesicle; spores immotile and without cilia, each putting forth an immotile infective body, often of flattened lobate shape.

Haptoglossa heterospora sp. nov.

Thalli hyalini, elliptici vel elongato-cylindrati, 7–350μ longi, 4–18μ crassi; sporangiis 1–6 humilibus papillis praeditis, per 1–4 ora 4–7μ lata dehiscentibus, aliis sporas 4.5–6μ crassas aliis sporas 8–10μ crassas eicientibus; sporis hyalinis, globosis vel rotundo-angulosis, corporibus inficientibus planis, 5–10μ longis, a latere lobo lingulato curvato 3–8μ longo apice attenuato instructis.

Vermiculos nematoideos multarum specierum enecans habitat in terra et humo silvestri et materiis plantarum putrescentibus in Maryland et Virginia et Wisconsin.

Vegetative thalli hyaline, ellipsoidal or elongate cylindrical, 7 to 350μ long, 4 to 18μ in transverse diameter, sporangia developing 1 to 6 short broad papillae of which 1 to 4 may be functional in providing apertures of dehiscence mostly 4 to 7μ wide. Spores hyaline, globose or with rounded angles, those produced in some sporangia 4 5 to 6μ in diameter, those produced in other sporangia mostly 8 to 10μ in diameter Infective bodies flattened, consisting individually of an axial portion 5 to 10μ long, together with a broad-based glossoid lobe mostly 3 to 8μ long, more or less upcurved at its tapering end

Destroying nematodes of many species, it occurs in soil, leaf mold, and decaying vegetable materials in Maryland, Virginia, and Wisconsin

MERISTACRUM ASTEROSPERMUM

A conidial phycomycete manifestly related to the entomogenous Entomophthoraceae was observed destroying nematodes in some agar plate cultures to which had been added pinches of leaf mold taken from deciduous woods near Butternut, Wis , in September, 1938 Among the eelworms subject to destruction several species belonging evidently to the genera *Rhabditis*, *Aphelenchoides*, and *Plectus* could be distinguished

Infection is accomplished by the fungus in question through the germination of a conidium or of several conidia attached to the integument of a susceptible animal, most often toward its anterior end (Fig 2, A, B, C). Usually the means of attachment is clearly visible in a sizable deposit of adhesive material between spore and integument The proximal portion of the germ tube -the portion most directly concerned in penetration of the integument --is commonly set off from its distal continuation within the fleshy interior by yellow coloration and somewhat irregular thickening of its wall When the invading element has attained a length of approximately 10μ, it widens abruptly to form a terminal swollen body, in which the protoplasmic contents of the conidium and infection tube then migrate The swollen body thereupon continues its development by extending itself lengthwise through the animal as a stout assimilative hypha or thallus Progressive destruction of musculature leads to increasingly pronounced disablement of the eelworm, and finally to its death Vegetative growth of the assimilative hypha comes to an end only when the digestible contents of the host have been completely appropriated

Early in the course of an epizootic within a petri-dish culture, infection of nematodes by single conidia is more frequent than infection by plural conidia Later, as conidia of the fungus become more abundant, plural infection, with resultant development of two (Fig 2, B, C, D), three, or four thalli, tends to predominate On conclusion of their vegetative growth the assimilative hyphae, with the exception of occasional small specimens, undergo division into a number of segments, which appear rather obviously homologous to the "hyphal bodies" familiar in the entomogenous genera *Empusa* and *Entomophthora*. Division in each instance is accomplished by deposition of a cross wall (Fig. 2, D, *b*, *c*) and subsequent disarticulation of the delimited parts. The thallodic segments may be elongate-ellipsoidal (Fig. 2, D, *a*, *e*), or somewhat curved-cylindrical (Fig. 2, D, *b*, *c*, *g*); or, again, may have a more irregular shape with bulging expansions (Fig. 2, D, *f*) or short diverticulate lobes (Fig 2, D, *d*)

Asexual reproduction may be considered to begin when the individual thallodic segment puts forth a hypha, about 3.5 to 5μ wide, that after emerging from the enveloping host integument grows through the overlying medium (Fig. 2, E, F) out into the air. If the host animal has succumbed deep in the medium, the outgrowing hypha often needs to make its way

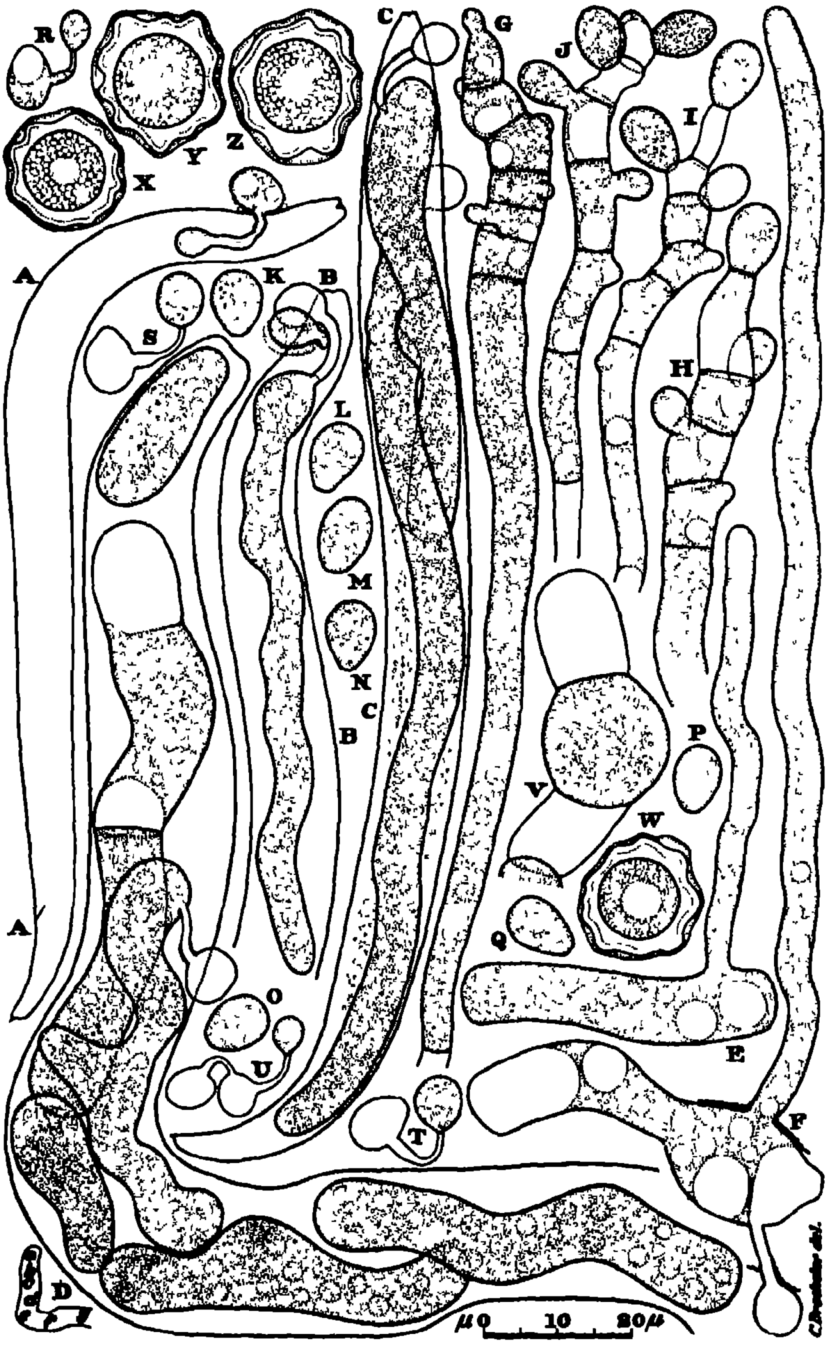

Fig 2.—(See opposite page for explanation)

through solid material for a distance of 1 to 3 mm; whereas if the animal happened to die on the surface the hypha may extend itself into the air immediately. The aerial hypha or aerial prolongation, usually less than 0.5 mm in length, widens out perceptibly in its distal portion, and rather commonly is disposed here in a helicoid spiral of two, three, or four turns (Fig. 3, A). Into this somewhat modified terminal portion of hypha is soon transferred all the protoplasm from the entire thallodic or reproductive unit. Transverse septa are now laid down in basipetal succession, dividing the densely filled hyphal termination into cells of approximately equal protoplasmic content. After a bud has been put forth terminally from the apical cell, a similar bud is put forth laterally in basipetal succession from each of the lower cells (Fig. 2, G), each of the buds receiving the entire protoplasmic contents of the parent cell (Fig. 2, H, I, J), and then being delimited by a basal septum as an obovoid conidium (Fig. 2, K–Q). Detachment of the conidia appears to ensue spontaneously soon after they attain full development. Once they lie on the surface of the medium they are ready to adhere to any susceptible nematode that may come in contact with them, such adhesion then inaugurating another sequence of endoparasitic and reproductive development. However, when opportunity for infection is not presented within a certain period of time, the detached conidium gives rise to a secondary conidium closely resembling the primary one except for its somewhat smaller size (Fig. 2, R, S, T). The secondary spore is regularly borne aloft a few microns above the surface of the medium by means of a delicate filament often more or less prostrate in its proximal portion, but ascending or erect in its distal portion. Through development similar to that whereby it originated a secondary conidium may in turn give rise to a tertiary one (Fig. 2, U).

Frequently a thallodic segment, instead of putting forth a conidiophorous filament, forms a resting spore. By continued enlargement of a vacuole at each end of the segment (Fig. 2, D, *b*) the granular materials are brought together into a globose mass, which then lays down two somewhat convex end walls to form a subspherical cell (Fig. 2, V). The densely granular contents of this cell now are converted into an endogenous spore that is provided with a separate wall of its own. This wall appears prominently scalloped in profile, and only rather loosely surrounds the coarsely granular subspherical

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Fig. 2.—*Meristacrum asterospermum*, drawn to a uniform magnification with the aid of a camera lucida, × 1000 throughout. A, Specimen of *Plectus communis* Bütschli showing early stage of infection by a germ-tube from an adhering conidium. B, Anterior portion of a specimen of *Rhabditis dolichura* with two adhering conidia, one of which has given rise to a growing vegetative thallus in the animal. C, Parasitized nematode, possibly referable to *Aphelenchoides* sp., the contents of which have been almost completely appropriated by two thalli. D, Portion of a specimen of *R. dolichura* containing seven thallodic segments of the fungus, *a*–*g*, one of these segments, *b*, which is not yet separated from its neighbor *c*, shows an early stage in the development of an azygospore, the other segments, *a*, *c*–*g*, subsequently put forth conidiophorous filaments. E, Thallodic segment from which a conidophorous filament is being put forth. F, Thallodic segment (with envelope of empty spore attached) likewise with an elongating conidiophorous filament. G, Sporiferous termination of conidiophorous filament, showing basipetal deposition of septa, and early stage in the budding forth of conidia from the delimited cells. H, I, J, Later stages in formation of conidia. K–Q, Disarticulated primary conidia. R, Primary conidium in process of producing a secondary conidium. U, Empty envelopes of a primary and a secondary conidium shown attached to a tertiary conidium. V, Same thallodic segment as D, *b*, but at a later stage, showing delimitation of the sporangial cell within which an azygospore is to be produced. W–Z, Mature azygospores, each within its sporangial wall.

protoplast, in which, on advancing maturity, a homogeneous central reserve globule may be distinguished (Fig. 2, W–Z).

With respect to the disposition of the membrane and contents of its resting spores the fungus shows striking similarity especially to the members of the genus *Endocochlus* (7), in the Zoopagaceae Although in the few known species of *Endocochlus* the resting spores are always formed as a result of sexual union between portions of separate thalli, development of azygospores in a manner inviting comparison with the fungus under discussion is present in at least one member of the Zoopagaceae, namely in *Zoopage cladosperma* Drechsler (7) Resemblance to the genus *Endocochlus* is expressed also in the production of conidia by individual segments delimited through deposition of cross walls in aerial hyphae This parallelism in asexual reproduction may well be of taxonomic significance despite some divergence in outward morphology apparent not only in the widening of the sporiferous termination, but also in its helicoid modification The fungus under discussion shows further similarity to many endoparasitic Zoopagaceae in the frequently rather extended migration of its protoplasm from deeply immersed thallodic segments to the aerial terminations of its conidiferous hyphae.

However, if the granular consistency and ready mobility of its protoplasm are considered together with the division and disarticulation of its vegetative hyphae into disconnected segments, the fungus appears more intimately akin to the Entomophthoraceae than to the Zoopagaceae. The indeterminate elongation of its conidiophorous filaments finds a close parallel in the indeterminate extension of external hyphae from the intramatrical mycelial segments in species of *Ancylistes*, a genus recently shown by Berdan (2) to be properly referable to the Entomophthoraceae In their obovoid shape the conidia of the fungus reveal a very obvious similarity to those of many species of *Empusa* and *Entomophthora* Often, besides, a fully developed conidium was seen to be attached to a dome-shaped protrusion of the parent cell, and the denuded empty conidiferous cells were nearly always found badly collapsed, much like conidiophores of *Conidiobolus villosus* Martin some time after their energetic discharge Although these details indicate a parallelism with the genera in the Entomophthoraceae known for their forcible projection of conidia, I did not succeed in demonstrating that the fungus under discussion likewise discharges its asexual spores forcibly It seems probable, however, that the primary conidia are actively propelled, though with much less violence than in species of *Empusa*, *Entomophthora*, and *Conidiobolus*. The secondary and tertiary conidia are almost certainly never shot away, but are produced and held in slightly elevated positions, where opportunity for contact with nematodes given to surface locomotion appears especially favorable

In the Entomophthoraceae the fungus is distinguished from those hitherto made known by its production of plural conidia, for the most part laterally, on a multiseptate conidiophore. It is accordingly described as the type of a new genus of that family A term compounded of two words meaning "divided" and "tip" respectively, is deemed an appropriate name for the genus. The sculpturing of its azygospore wall suggests for the fungus a specific epithet made up from two words meaning "star" and "seed," respectively.

Meristacrum gen. nov.

Hyphae assumentes intra animalia viva crescentes, simplices vel nonnihil ramosae, primo continuae, postea—animali emortuo et carne ejus consumpto—in aliquot partes se diffindentes, his partibus disjunctis aut hyphas fertiles emittentibus aut sporas perdurantes (zygosporas vel azygosporas) gignentibus, hyphis fertilibus in aere se porrigentibus, sursum protoplasmatis repletis, ibi primo continuis, deinde transverse multiseptatis, ex quaque cellula conidium proferentibus.

Vegetative hyphae developing within living animals, simple or somewhat branched, at first continuous, later (after death of the animal and exhaustion of its fleshy contents) often dividing into disjointed segments, which either put forth conidiophorous hyphae or give rise to resting spores (zygospores or azygospores); the individual conidiophorous hypha extending some distance into the air, in its densely filled terminal portion becoming divided by transverse septa into a number of cells, each of which then produces a single conidium.

Meristacrum asterospermum sp. nov.

Hyphae assumentes hyalinae, simplices vel parvulum ramosae, saepius 50–500μ longae, 5–12μ crassae, in articulos disjunctos plerumque 25–60μ longos se diffindentes; quoque articulo mox utrimque rotundato, aut unam hypham fertilem emittente aut unam azygosporam gignente; hyphis fertilibus saepe 0.5–3 mm longis, 200–500μ in aere se porrigentibus, parte propiore saepe immersa 3–5μ crassa mox vacua et sparsum septata, parte ulteriore aeria saepius in spiram levem contorta, 6–9μ crassa, primo protoplasmatis repleta, continua, deinde in 5–15 cellulas 4–20μ longas divisa quae singula conidia proferunt. Conidiis hyalinis, obovoideis, plerumque 8–11μ longis, 6–8μ crassis, modo singulas hyphas germinationis circa 10μ longas, 1.5μ crassas in vermiculum nematoideum intrudentibus, modo quoque unum conidium ordinis secundi ex hypha germinationis assurgente 5–10μ longa, basi circa 2μ et apice 0.8μ crassa ferente. Azygosporis hyalinis vel flavidulis, globosis, circa 15–20 crassis, maturitate membrana late verrucosa vel undulata cellulam viventem sphaeroideam 11–14μ crassam laxe circumdante.

Vermiculos nematoideos enecans habitat in humo silvestri prope Butternut, Wisconsin.

Vegetative hyphae hyaline, simple or slightly branched, mostly 50 to 500μ long, 5 to 12μ wide, when well developed dividing into segments 25 to 60μ long; the thallodic segments becoming rounded at their ends, each putting forth a single conidiophorous filament or giving rise to a single azygospore. Conidiophorous filaments mostly 0.5 to 3 mm long, usually extending 200 to 500μ into the air, the proximal part usually 3 to 5μ wide, soon becoming empty and septate at long intervals; the distal prolongation, often 6 to 9μ wide and noticeably disposed in a helicoid spiral, becoming divided through basipetal deposition of transverse cross walls into 5 to 15 cells, mostly 4 to 20μ long, each of which by budding gives rise to a single sessile, hyaline, obovoid conidium, 8 to 11μ long and 6 to 8μ wide. Conidium after disarticulation often adhering to a nematode, then thrusting into it an infective germ tube, about 10μ long and 1.5μ wide, which develops into a vegetative hypha; or, failing to adhere to a nematode, giving rise on an ascending sporophore, 5 to 10μ long, 2μ wide at the base, and 0.8μ wide at the tip, to a somewhat smaller secondary conidium. Azygospore loosely contained within the wall of its parent cell, colorless or slightly yellowish, subspherical, 15 to 20μ in diameter, its pronouncedly undulated wall loosely enveloping a subspherical protoplast 11 to 14μ in diameter.

Parasitic on nematodes it occurs in leaf mold in deciduous woods near Butternut, Wis.

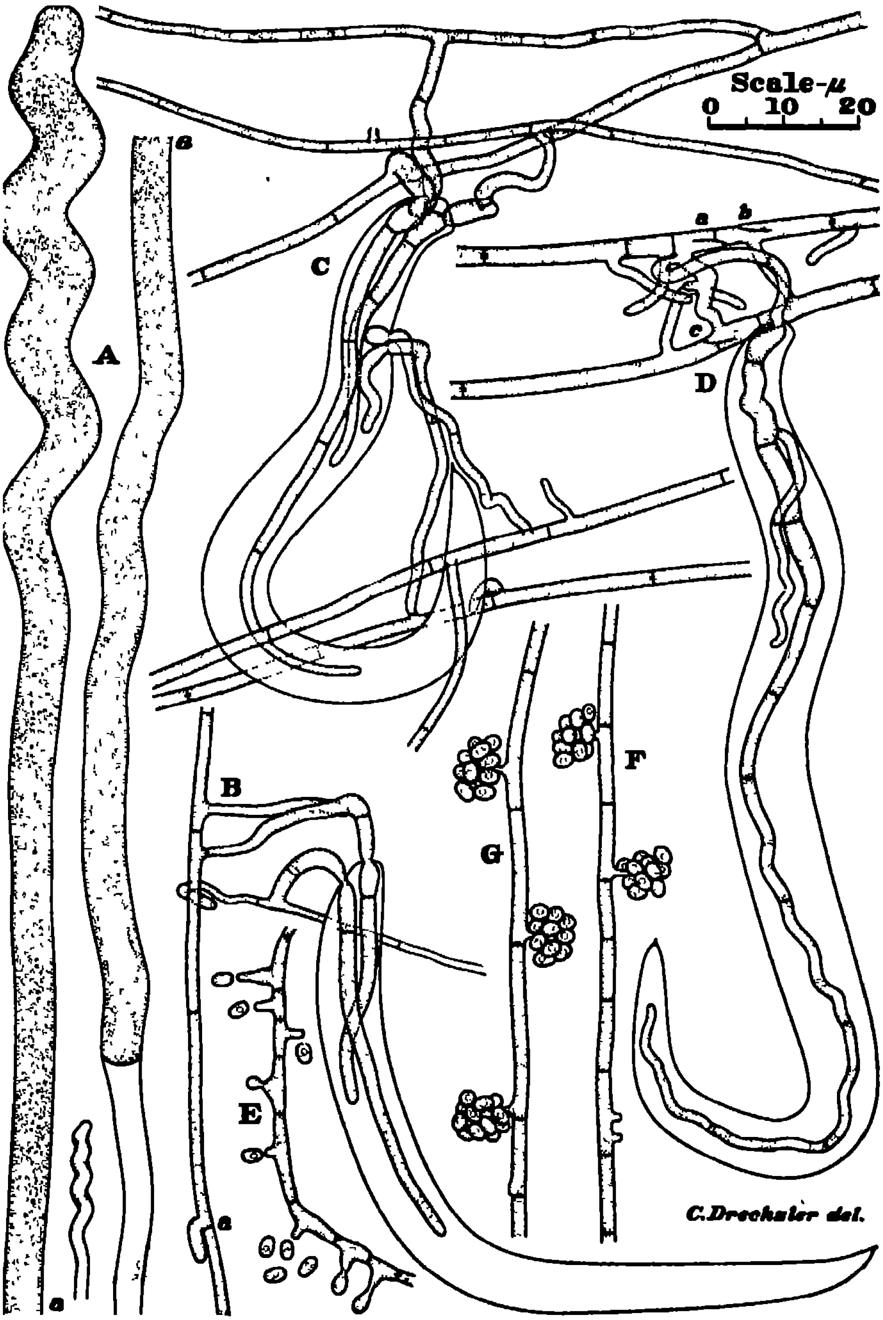

Fig. 3.—(See opposite page for explanation)

CEPHALOSPORIUM sp.

A fungus subsisting on eelworms, yet hardly deserving to be considered either predaceous or vigorously parasitic on these animals, was observed in a few nematode-infested agar cultures to which had been added some pinches of partly decayed tobacco leaves (*Nicotiana tabacum* L.) from a greenhouse near Beltsville, Md. In these cultures it apparently obtained its nourishment exclusively from specimens of *Plectus communis* Bütschli and *P. parvus* Bastian that had become disabled as a result of extensive infection by a protozoan endoparasite producing minute subspherical spores. When a disabled animal was halted near mycelial hyphae of the fungus, these hyphae would send out one or several branches, which soon perforated its integument and intruded a corresponding number of haustorial elements (Fig. 3, B, C, D). In most instances of plural penetration only one or two of the haustorial elements attained extensive development, apparently because the fleshy contents of the eelworm had already in large part been appropriated by the protozoan. Similar restriction of hyphal development within nematodes disabled and partly expropriated of contents by a protozoan parasite was noted earlier in my account (10) of the feebly predaceous *Tridentaria doedycoides* Drechsl.

Although its general habit recalls that of the more delicate species in the predaceous series of hyphomycetes, the fungus at present can neither be definitely assigned to nor excluded from that series. Its mycelial hyphae vary from 1 to 3μ in width. In addition to branches of indeterminate length, they bear here and there short spurlike branches that are often more or less appressed to the parent filament (Fig. 3, B, *a*). Ordinary cross walls occur in the mycelial hyphae at moderate intervals, and are supplemented by curiously oblique partial septa, which sometimes appear alone (Fig. 3, D, *b*), and at other times occur united to partial cross walls (Fig. 3, D, *a*, *c*). Infective branches are often noticeably stouter than the filaments from which they arise. The haustorial hyphae are often wider in their proximal portions than in their distal prolongations.

Hyaline ellipsoidal spores, commonly 2.5 to 3μ long and 1.5 to 2μ wide, are produced by the fungus on tapering branches, mostly 1.5 to 4μ long, and 1 to 2μ wide at the base. Owing, perhaps, to repeated disturbance by nematodes, these spores, when developed on the surface of a culture, show only a very promiscuous arrangement (Fig. 3, E), whereas in submerged and consequently better protected positions they are found in capitate clusters numbering ten to twenty individuals (Fig. 3, G, F). They have never been observed to infect nematodes, yet their small size would seem to make them incapable of giving rise to mycelia of such extent that disabled eelworms

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Fig. 3.—Drawn to a uniform magnification with the aid of a camera lucida, × 1000 throughout. A, Sporiferous termination of a conidiophorous filament of *Meristacrum asterospermum*, showing its distal disposition in an extended helicoid spiral. B, Specimen of *Plectus communis* which, after its disablement by a protozoan parasite, is being invaded besides by two hyphae of *Cephalosporium* sp.; *a*, a short spurlike hyphal branch. C, Another disabled specimen of *P. communis*, penetrated by five hyphal branches of *Cephalosporium* sp. D, Specimen of *P. parvus* Bastian, disabled by protozoan parasite and then further invaded by a branching filament of *Cephalosporium* sp.; *a–c*, three oblique partial septa. E, Superficial hypha of *Cephalosporium* sp. with several spore-producing sterigmata. F, G, Submerged filaments showing clusters of spores at the tips of lateral sterigmata. (Owing to lack of space, *A* is shown in two parts, which are connected in *a*. The small sketch, in which the lower portions of the successive turns are stippled, is intended to show more clearly the direction of rotation in the helicoid termination.)

might become a likely source of nourishment These circumstances suggest that the *Cephalosporium* stage present here may constitute an accessory reproductive phase in the development of the fungus, rather than its main conidial phase

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BOTANY.—Atropellis *species from pine cankers in the United States.*[1]

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INTRODUCTION

In various areas of the United States certain dermateaceous or tryblidiaceous fungi occur in association with twig or stem cankers of one or more species of *Pinus*, most frequently of species of hard or pitch pines (subgenus *Diploxylon* Koehne). These diseases, recently summarized by Boyce (1), have attracted the attention of pathologists only during the past 25 years.

The first was reported in 1921 by Weir (11), who described *Cenangium piniphilum* as a new species associated with stem cankers of *Pinus contorta* Loud. and *P. ponderosa* Lawson in Idaho and Montana. At that time Overholts (8) had observed cankered twigs of *P. rigida* Mill. in Pennsylvania, and later in the same State similar cankering of *P. pungens* Lamb., and considered the fungus associated to be a species of *Crumenula*, one possibly identical with *C. pinicola* (Rebent.) Karst., which has been reported (5, 7) as pathogenic to pines in Europe. Subsequently, Zeller and Goodding (13) described *Atropellis pinicola* as a new species in association with branch and stem cankers of several species of pine in the Pacific Northwest. They allied the fungus with *Scleroderris treleasei* Sacc. of Alaska in a new genus, *Atropellis*.

In 1932 specimens of *Atropellis* canker collected on *Pinus sylvestris* L. near Portsmouth, Ohio, and near Mount Alto, Pa., were received by the Division of Forest Pathology, U. S. Bureau of Plant Industry.[2] The following year an investigation of the disease was undertaken by the Civilian Conservation Corps, in cooperation with the Forest Service and the Division of Forest Pathology, and from the field surveys made approximately 500 collections of canker fungi accrued. The writers have had the opportunity to classify these specimens, which are largely from the Eastern and Southeastern States (2, 3). The present paper is concerned with the taxonomy of specimens representative of the various susceptible hosts in these areas, studied in comparison with authentic specimens of the canker fungi in the Western States.

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[1] Received December 13, 1939.

[2] Collections by Dr. Curtis May and Dr. L. W. R. Jackson, respectively; also reported to the Division of Forest Pathology by Prof. J. S. Boyce as occurring on *P. sylvestris* and *P. resinosa* Soland. in Massachusetts and New Hampshire.

TAXONOMY OF SPECIES ON PINES

With respect to the previously mentioned so-called *Cenangium*, *Crumenula*, and *Atropellis* cankers in the United States, which are characterized by a grayish-green to blue-black coloration of the wood (Fig. 1, c) beneath each lesion (1), the causative fungi seem to be sufficiently closely related to be properly considered within a single genus. In some features, particularly the roughened exciple and the elongate, septate spores, the species here referred to *Atropellis* resemble those of *Crumenula* described as occurring on pines in Europe. The latter, however, are characterized by Rehm (9) and Lagerberg (7) as having the apothecium with circular opening, entire margin, pale hymenium, and long, fine excipular hairs. The American fungi differ from *Crumenula* in the furfuraceous exciple, stellate or irregularly lacerate aperture, and blue-black epithecium, as well as in the type of canker produced and the characteristic discoloration of the host tissue by the mycelium. In their clavate to elongate-fusoid ascospores the species are suggestive of *Scleroderris* as used by Karsten (6) and Rehm (9) but are dissimilar with respect to paraphyses, aperture, and exciple. It has been suggested that a possible relationship exists between these species and *S. bacillifera* (Karst.) Sacc., as mentioned by Zeller and Goodding (13). This fungus, however, as represented by Karsten's *Tympanis bacillifera* (Fung. Fenn. 756, Cent. 8, 1868, in the Farlow Herbarium, Harvard University) on bark of *Picea* ("granbark") has *smooth, patellate apothecia*, which conform in gross and microscopic features to the description by Karsten (6, cfr. Saccardo, Sylloge Fung. **8**: 595) and, except for arrangement of spores to that by Rehm (9). In the writers' preparation of F. Fenn. 756 ascospores are 0- to 5-septate, 22–36 by 3–3.5μ, subspirally overlapping, with three or four in the apex of the ascus.

It seems advisable, therefore, to recognize *Atropellis* as a distinct genus for the species associated with pine cankers in the United States, with certain revisions of the genus and species as described by Zeller and Goodding (13, p. 561) for pines.

Atropellis Zeller and Goodding, emend

Apothecia erumpent, externally furfuraceous and brownish to black, fleshy coriaceous, single or cespitose, sessile to substipitate, cupulate to patellate, laciniately dehiscent, hymenium concolorous, bluish black or lighter, asci clavate, 8-spored; spores fusoid to narrow cylindrical-clavate, hyaline, continuous, then 1- to 3- (rarely 5-) septate; paraphyses hyaline, septate, simple or branched, exceeding the asci, end cells equal or slightly swollen, forming a colored epithecium, agglutinated below and granular encrusted above by yellowish-brown, pinkish, or violaceous excretion; hypothecium typically thick, subtended by a hyaline medullary tissue, ectal layer dense, dark, furfuraceous

Conidial stromata, where known, of similar habit, texture, and color; fertile cavities variable, usually coalescing, the pustules dehiscent by one or more papillulae, conidiophores simple or subverticillately branched; conidia minute, acrogenous, bacillar, continuous, hyaline.

In each of the following species the pinkish or violaceous material in and above the hymenial tissue of both conidial and apothecial fructifications is readily dissolved by sodium or potassium hydroxide solutions, which are immediately colored greenish or bluish If a hydroxide solution is used as a swelling agent in microscopic preparations, the cytoplasm of young asci and ascospores appears greenish rather than hyaline Overholts (8) describes this reaction in his account of the fungus associated with the canker of *Pinus pungens*, presumably the second of the following species.

Atropellis pinicola Zeller and Goodding Fig 2, A–B

Zeller and Goodding (13) record *A pinicola* on *Pinus contorta* Loud and *P. lambertiana* Dougl. in Oregon, and on *P monticola* D Don in Oregon, Washington, Idaho, and British Columbia. Zeller (12) also reports the species on *P lambertiana* in California and on *P strobus* L. in Oregon

Atropellis pinicola differs from the three following species primarily in its longer and narrower spores, which Zeller and Goodding, upon the examination of numerous specimens, record as "32–63×1 5-3 5μ (average 40×2μ)," and in its more frequent occurrence on soft pines Specimens examined by the writers have spores typical in size and shape, although not uniformly 1-celled as originally described, but frequently 2- to 4-celled, and occasionally 6-celled[3] The paraphyses are septate, simple or forked, with the tip cells equal, or swollen and up to 4μ in diameter. The conidial fructifications and conidia observed conform to the descriptions under the succeeding species (Cf 12, p. 464)

Atropellis tingens sp nov Fig. 1, B, C, F–H, Fig 2, C–L

Apotheciis sessilibus vel substipitatibus, ex cortice erumpentibus, subglobosis dein *patelliformibus*, coriaceis, 2–3 mm diam , *furfuraceis*, atris, margine laciniato, hymenio atro-coeruleo, ascis clavatis, longe pedicellatis, octosporis, (70) 90–110 (150)×8–10 (14)μ; ascosporis 2–3-seriatis, anguste fusiformibus, rectis, curvatis vel sigmoideis, (20) 24–40 (46)×(2) 2 5–3.5 (4)μ; paraphysibus simplicibus ramosisve, apice incrustatis, epithecium atro-coeruleum formantibus, hypothecio brunneo, strato interiore hyalino, cortice denso, atro, rugoso; fructibus conidicis pustulatis, atris, furfuraceis, plicatis; conidiophoris ramosis, 35×1 5μ; conidiis bacillaribus, continuis, hyalinis, 4 8×0 5–0.7μ. *Hab in cortice ramorum vivorum Pini.*

Apothecia sessile to substipitate, single or gregarious, erumpent through the bark of cankered areas, often concentrically arranged, subglobose when young, expanded to cup-shaped or patellate, contorted or compressed when crowded, opening by irregular splitting, coriaceous, 2–3 mm diam , exterior black, furfuraceous, margin laciniate, incurved, when dry often hysteroid

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[3] Specimens examined Oregon Agr. Coll. Herbarium no 4877 (courtesy of S M Zeller); nos 1304, 1635 (ex type), 1670, 1968, and 1969 in the herbarium of J S Boyce, Yale University; Forest Pathology nos 86401–86405; Mycological Collections, U S Bureau of Plant Industry, nos 66565–66567, 71100–71104.

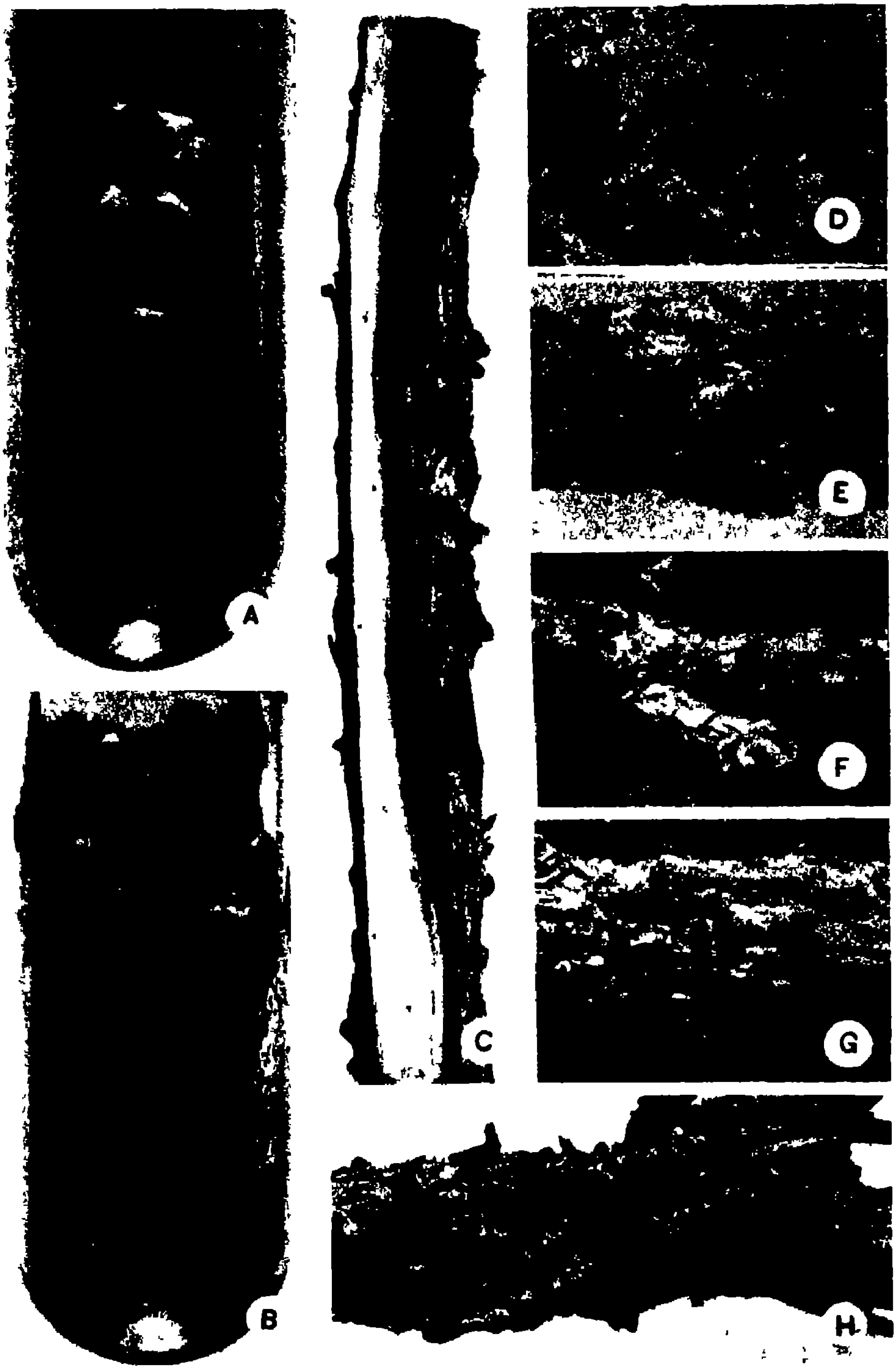

Fig 1 — (See opposite page for explanation)

in form, hymenium blue-black, pruinose. Asci clavate, long-pedicellate, apex rounded, 8-spored, (70) 90–110 (150)×8–10 (14)μ, spores irregularly 2–3 seriate in the upper part of the ascus, slender fusiform, broadest near the apex and tapering below, straight, curved or sigmoid, hyaline, continuous then 1–3 (rarely 4–5) septate, (20) 24–40 (46)×(2) 2.5–3.5 (4.0)μ; paraphyses sometimes simple, more frequently branched and slightly thickened at the tips, septate, subhyaline, granular-encrusted, forming a dense purplish- or bluish-black epithecium. Hypothecial layer 20–25μ thick, brown; underlying tissue of fine, loosely interwoven, hyaline or subhyaline hyphae, forming a layer 70–110μ thick, cortex 30–100μ thick, very dense, black, roughened on the outer surface by clumps of thick-walled, brown, closely septate hyphae. Conidial fructifications pustulate, erumpent, black, furfuraceous as in the apothecia, irregularly chambered or folded, the folds lined with branched conidiophores 35×1.5μ, conidia borne at the tips of the branches, bacillar, continuous, hyaline, 4–8×0.5–0.7μ.

On cankered twigs, branches and small stems of *Pinus banksiana* Lamb., *P. caribaea* Morelet, *P. clausa* (Engelm.) Sarg., *P. densiflora* Sieb. & Zucc., *P. echinata* Mill., *P. nigra* Arn., *P. pinaster* Ait., *P. pungens* Lamb., *P. resinosa* Soland., *P. rigida* Mill., *P. rigida* var. *serotina* (Michx.) Loud., *P. strobus* L. (infrequent), *P. taeda* L. and *P. virginiana* Mill., from New Hampshire to Florida, west to Ohio and Arkansas (2, 3). Type specimen: *Diller* 24 on *Pinus rigida*, Camp Roosevelt, George Washington National Forest, Va., June 12, 1933.[4] All of the specimens on *Pinus strobus* were obtained near Mount Solon, Va.

The ascospores of this species are regularly shorter and broader than those of *Atropellis pinicola*, averaging approximately 30×3μ, but of the same degree of variation. With respect to a single apothecium, spores in general are less variable in width than in length. When relatively broad ascospores are encountered, they are of the shape characteristic of the species and average considerably longer than those of the next succeeding species.

The specimens examined show that apothecia with mature spores may be found throughout the year, as Zeller and Goodding note for *Atropellis pinicola*. Yet much sterile material is encountered among samples from the surveys and among the writers' casual collections made during all seasons of the year. Possible perennial sporulation on living or weakening twigs and stems is suggested by the arrangement of the apothecia and degrees of development on cankers of long standing.

While this species is suggestive of *Atropellis pinicola* in the shape and arrangement of the ascospores and of the following species in its general occurrence on hard, rather than soft, pines, it is clearly intermediate to the two with regard to spore size.

[4] The type and other respresentative specimens are deposited in the Mycological Collections, U. S. Bureau of Plant Industry, portions of the type and several other collections are also in the Farlow Herbarium of Harvard University and the herbaria of the New York Botanical Garden and the University of Michigan.

Fig. 1.—A–B, Seven-weeks-old cultures of *Atropellis* on malt agar medium, kept at room temperature. A, *Atropellis arizonica* from *Pinus ponderosa*, B, *A. tingens* reisolated 21 months after *Pinus echinata* was inoculated with a culture from *P. caribaea*. C–H, *Atropellis* on various pines. C, *A. tingens* on *P. pungens*, North Carolina, D, *A. piniphila* on *P. ponderosa*, Idaho, E, *A. arizonica* on *P. ponderosa*, Arizona, F, *A. tingens* on *P. sylvestris*, Ohio; G, *A. tingens* on *P. taeda*, Virginia, H, *A. tingens* on *P. pinaster*, North Carolina. Figures A–H, ×2; all photographic negatives by M. L. F. Foubert.

The species grows very slowly in cultures held at room temperature, producing uneven, elevated, black, compacted or loosely stromatic surface mats of irregular outline and with scattered and marginal, fine grayish to violaceous tomentum on potato-dextrose and malt agar media, and less erumpent colonies with black subsurface mycelioid margins on corn meal agar Identical colonies were obtained from plantings of infected wood of various species of pines The conidial stage developed in irregular, convoluted areas, was observed in isolations from *Pinus banksiana* Lamb , *P caribaea* Morelet, *P echinata* Mill , *P. pinaster* Ait., and *P. pungens* Lamb.,

Atropellis piniphila (Weir) comb. nov Fig 1, D; Fig 2, M

As mentioned above Weir (11) reports this fungus as *Cenangium piniphilum* on *Pinus contorta* and *P. ponderosa* in Montana and Idaho More recent accounts (1, 12) indicate its further occurrence in the Pacific Coast States on these hosts and on *P albicaulis* Engelm , and (4) in Arizona and New Mexico on *P ponderosa* Specimens examined in the present study add other hosts and extend the range of the species to New Mexico and stations in the Southeast[5] The species occurs on both soft and hard pines but infrequently on the former

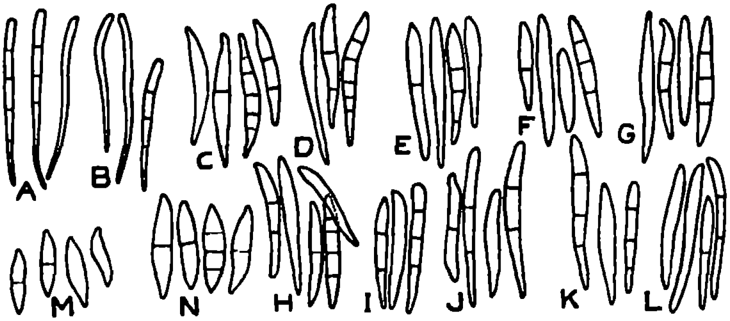

Fig 2 Ascospores of four species of *Atropellis* ×500 A, *A pinicola* on *Pinus monticola*, Oregon, B, same on *P contorta*, Oregon; C L, *A tingens* on various pines in the Eastern States (*Pinus virginiana*, *taeda*, *pungens*, *caribaea*, *sylvestris*, *banksiana*, *echinata*, *rigida*, *resinosa*, and *strobus*, respectively), M, *A piniphila* on *Pinus contorta* (type specimen); N, *A arizonica* on *Pinus ponderosa*

The apothecia are as characterized for the genus, with the hymenium brownish to black, averaging somewhat larger than those of the two preceding species. The asci are longer and broader, measuring (100) 120–135 (170)×10–15μ, and the tendency for the spores to be clumped in the upper end also obtains in this species, with the upper two to six spores biseriate overlapping. Paraphyses are septate, simple or branched, with the tip cells equal or swollen. The hymenium in section shows the purplish tints characteristic of species of this group. Ascospores are elliptical-fusoid, with ends rather acute, straight or subsigmoid, and measure (14) 16–22 (24)×(3.5) 4–5 (5.5)μ, averaging 18×5μ in the type specimen. While Weir describes and illustrates the spores as 1-celled, 1- and 2-celled spores occur in half of the specimens listed herein, including the type. The conidial stage observed in association with apothecia (Boyce number 1659) is morphologically identical with that of *A. tingens*.

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[5] Specimens examined *Weir* 2631 (locality unknown, probably Dakotas), on *Pinus banksiana* Lamb ; *Weir* 2624 and 2625 (Idaho), 2626 (Montana), 2627 (Washington), and *Forest Pathology* 14973 (type) and 15532 (Idaho), all on *P contorta* Loud; *Weir* 2633 (Oregon), *P jeffreyi* "Oreg Com "; *Weir* 2628 (Idaho), *F P* 89367 *Gill & Ellis* (New Mexico), *P ponderosa* Lawson, *Weir* 2630 (Alabama), *P taeda* L —all in Mycological Collections, U S Bureau of Plant Industry, *Boyce* 766 (ex-type), and 1659 (Idaho), *P monticola* D Don —Herbarium of J S Boyce, *Diller* 311 (Tennessee), *P. virginiana* Mill —courtesy of J D Diller

Sydow and Petrak (10) determine this fungus as *Cenangium farinaceum* (Pers.) Rehm, which occurs on branches of *Pinus sylvestris* in Europe, making particular note of the coloration in the hymenium ("Paraphysen") and epithecium. Rehm (9) notes that in this respect *C. farinaceum* differs from other species of *Cenangium*. The accounts, however, do not indicate that the European fungus is pathogenic or that it discolors the wood. On the basis of Rehm's description *C. farinaceum* has smaller asci and shorter and broader, 1-celled spores, which have obtuse rather than acute ends. Whatever the relationship between these fungi may be, the American specimens can not be identified as *Peziza pinicola beta caespitosa* of Fries (Syst. Myc. **2**: 113, *Peziza farinacea* Pers., Syn. Fung., p. 672), which in the specimen distributed by Fries ("294 *Peziza farinacea* b Syst. Myc." in the Farlow Herbarium, Harvard University), shows numerous flattened, smooth, black and shining apothecia up to 0.6 mm broad when dry, occurring singly or clustered on a large sheet of bark sufficient to indicate that fruiting was not associated with a canker condition. Therefore, the synonymy that Sydow and Petrak suggest is considered untenable.

Atropellis arizonica sp. nov. Fig. 1, A, E, Fig. 2, N

Apotheciis substipitatibus, ex cortice erumpentibus, subglobosis dein expansis, coriaceis, atris, 1.2–2.5 mm diam., furfuraceis, margine undulato, laciniato, incurvato, hymenio pruinoso, atro-coeruleo, ascis cylindrico-clavatis, apice obtusis (90) 100–120×9–14μ, ascosporis 2-3-seriatis, elliptico-fusoideis, rectis vel subsigmoideis, continuis vel 1-3-septatis, (20) 24–28 (32)×(4) 4.5–6 (7)μ, paraphysibus filamentosis, septatis, ramosis, hypothecio brunneo, strato interiore hyalino, cortice crasso, atro, rugoso, fructibus conidiis pustulatis, nigris, conidiophoris ramosis, 12–20×2μ, conidiis bacillaribus, hyalinis, continuis, 4–6×1–1.5μ. Hab. in cortice ramorum vivorum Pini.

Apothecia substipitate, erumpent singly or in groups of two to three, scattered over bark of cankered areas of the host, subglobose when young, then expanded and patellate, sometimes irregularly contorted and compressed when crowded, leathery, black, 1.2–2.5 mm diam., exterior furfuraceous, margin undulate, laciniate, incurved when dry, hymenium pruinose, blue-black. Asci cylindrical-clavate, obtuse at the apex, gradually attenuated toward the base, 8-spored, (90) 100–120×9–14μ, spores irregularly 2-3-seriate in the upper part of the ascus, 1-2-seriate below, elliptic-fusoid, straight or subsigmoid, tapering at both ends, continuous to 1-3-septate, equal or slightly constricted at the central septum, (20) 24–28 (32)×(4) 4.5–6 (7)μ, paraphyses filamentous, septate, branched above, the tip cells equal or swollen, dilute pinkish in mass, covered by a dense blue-black epithecium. Hypothecium brown, 45–65μ thick, inner layer of tissue 100–150μ thick, of loosely interwoven, subhyaline hyphae; cortex 100–250μ thick, black, dense, exterior roughened and covered with loose clumps of dark, closely septate hyphae. Conidial fruits pustulate, black, furfuraceous as in the apothecia; conidiophores simple or branched, pale violaceous in mass, 12–20×2μ; conidia bacillar, hyaline, continuous, 4 6×1–1 5μ

On stems of *Pinus ponderosa* Lawson, Hospital Flat, Safford, Ariz, September 22, 1934, D J Stouffer

This species is known only from the locality of the type specimen, which was obtained at an elevation of 9,000 feet. It is closely allied with *A. piniphila* but has longer and broader spores, in their form suggestive of certain species of *Crumenula* on pines in Europe In cultural aspects the species resembles *A tingens*. The conidial stage was obtained in cultures from isolated groups of ascospores discharged upon plates of nutrient agar.

SUMMARY

The genus *Atropellis* is revised to include along with *A. pinicola* Zeller and Goodding, of the Pacific Northwest, two new species, namely, *A. tingens* and *A. arizonica*, and *Cenangium piniphilum* Weir, all of which cause characteristic cankers of pines. Of these *A. tingens* is of widest occurrence, on various species of native and introduced pines in the eastern half of the United States, and *A. arizonica* is most limited in distribution, being known only from the type locality, Safford, Arizona. Each of the species produces a localized, dark stain of the wood in cankered twigs or stems.

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ENTOMOLOGY.—*New genera and species of lady-beetles related to* Serangium *Blackburn (Coleoptera: Coccinellidae)*[1]

Edward A. Chapin, U. S. National Museum.

This paper has been prepared primarily to supply names for certain species of coccinellid beetles of economic importance. In the course of the work dissections of representatives of a great many genera were made, and it became evident that in many places the accepted classification of the family is faulty. More attention must be paid to the structures of the head and abdomen before a system can be outlined that will be justified by the morphology of the species involved. The division of the family into its major groups will, I believe, be based mainly on the structure of the mandible. Such a system was suggested in 1843 by Redtenbacher.[2]

Thanks are due to Miss Hazel Bowen, who has prepared the figures illustrating the essential characters of the genera discussed.

The genera and species considered in this paper form a very compact group within the family Coccinellidae. This group is the Oeneini of Casey, 1899, minus the genus *Oeneis* Mulsant, 1850. As the species placed in *Oeneis* must be associated with *Cryptognatha* Mulsant, 1850, and not with *Delphastus* Casey, 1899, and as the name *Oeneis* is not available for use in the Coccinellidae because of its prior use in Lepidoptera by Hübner, the tribal name Oeneini must be abandoned. It seems undesirable at present to propose a new name in view of our lack of exact knowledge of the structure of most of the small Coccinellidae.

It is advisable here to discuss certain generic segregates that have been presumed to be related to this group:

Lioscymnus Champion, 1913, is determined, after an examination of a paratype of the type species, to be a synonym of *Delphastus*.

Delphastobia Casey, 1924, is determined, after examination of the type species and specimen, to be a chrysomelid related to or belonging to the genus *Lamprosoma*.

Delphastopsis Casey, 1924, is determined, after examination of the type species and specimen, to be close to and possibly a member of the genus *Scymnillus*.

Semichnoodes Weise, 1892, is, according to notes by Sicard, 1909, not related to *Serangium*.

Serangium monticola Sicard, 1909, is, according to the original description and figure, not related to *Serangium*.

The species belonging to this group have the following characters in com-

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[1] Published by permission of the Secretary of the Smithsonian Institution. Received January 15, 1940.

[2] *Tentamen dispositionis generum et speciorum coleopterorum* . . ., 32 pp., Vidobonae, 1843. Reprinted in Germar's Zeitsch. Ent. 5: 113–132. 1844.

mon: Form very compact; head convex in front, antennae with the terminal segment spatulate and very long in comparison with other segments, pronotum finely margined throughout, prosternum strongly developed anteriorly as a plate protecting the mouth parts when head is in position of repose, notched on each side near lateral margins for the reception of the antennae; elytral epipleura moderately broad, with cavities for the reception of the tips of the middle and posterior femora; legs received in deep cavities on under side of body, those for the front legs being on the prosternum, for the middle legs on the suture separating the meso- and metasternum and for the hind legs mostly on the first abdominal sternite, femora broad and flat, completely concealing the tibiae when legs are retracted, abdomen with five visible sternites, the second, third, and fourth being quite short in comparison with the first and fifth.

After the elimination of the genera mentioned above, there remain two described genera having the characteristics listed in the preceding paragraph and two as yet unnamed. These four may be separated in the following manner:

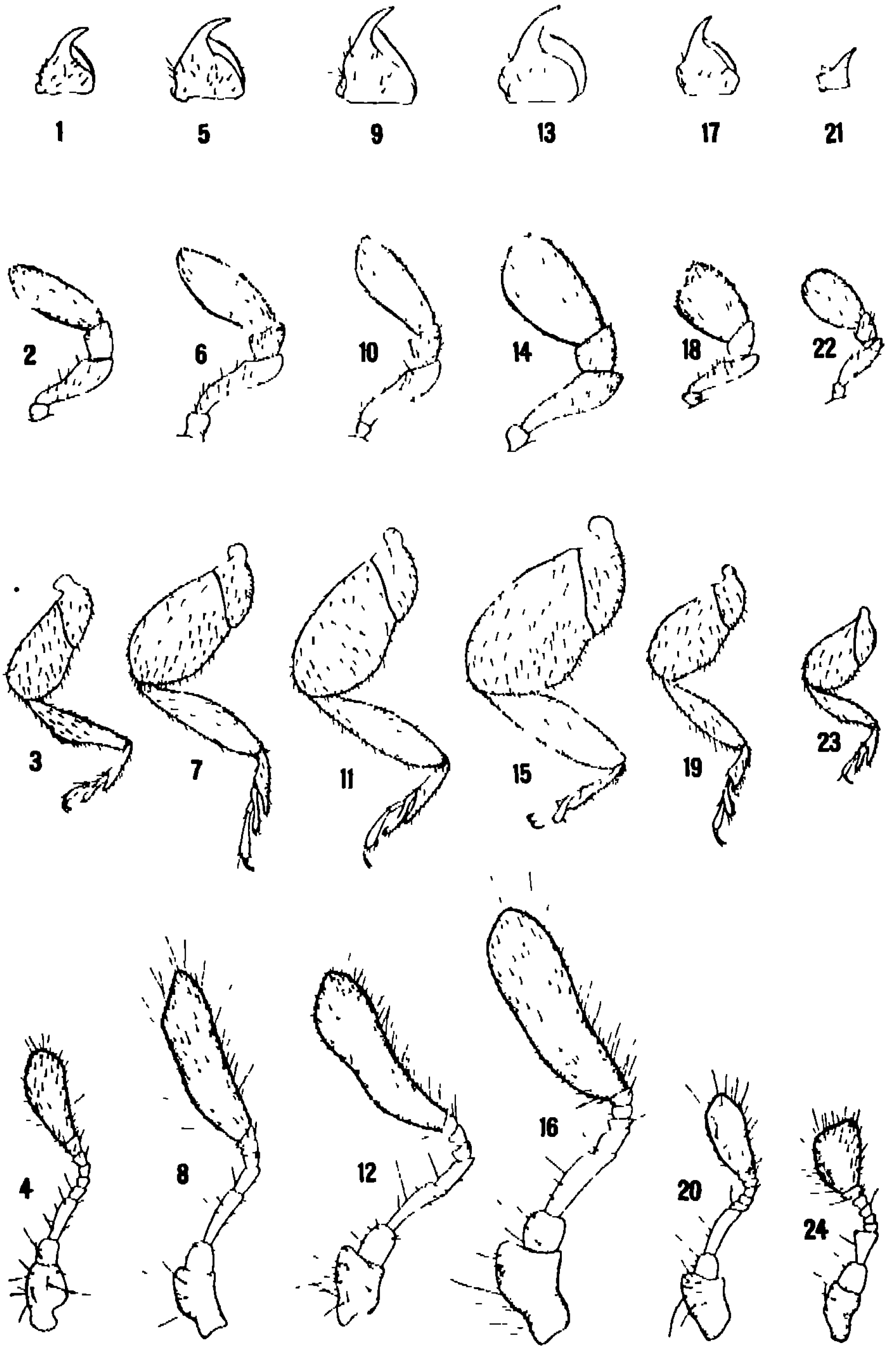
1. Antennae 8-segmented; size large (length 2–2.5 mm), middle and hind tibiae not angulate externally, Oriental region ..... *Catana*, new genus
   Antennae 9-segmented, size small to medium (up to 2 mm) 2
2. Middle and hind tibiae slender, not angulate externally; size medium (1.5–2 mm), Oriental, Ethiopian, and Australian regions ..... *Serangium* Blackburn
   Middle and hind tibiae angulate externally 3
3. Third segment of antennae obtriangular, twice as wide at apex as fourth segment, tibiae without teeth at apex of angulation, size small (about 1 mm), Ceylon ..... *Serangiella*, new genus
   Third segment of antennae cylindrical, not much wider at any point than fourth, tibiae with usually two denticles at angulation of tibiae, size small to medium (0.8–1.5 mm), New World ..... *Delphastus* Casey

Delphastus Casey, 1899

While it is not possible at present for me to give a key to all the species, it is desirable to give names to two species that are frequently submitted for identification. The essential characters of the type species of the genus, *Delphastus pusillus* (LeConte), are illustrated in Figs. 1–4.

Delphastus nebulosus, n. sp.

Length 1.0 mm, width 0.8 mm, altitude 0.5 mm. Pale yellow-brown, legs whitish, elytra each with a single basal castaneous spot of indefinite extent. Integuments shining. Head not visibly punctured except for a very few minute setigerous punctures. Scutellum very small, not visibly punctured. Elytra without visible punctures, but with pellucid dots grouped along the suture and lateral margin and on apical portion. Two or three setae occur on each elytron in the region of the humeral callus, and a few very short setae along the lateral margin toward the apex; otherwise the elytra are glabrous. The dark spot extends along base from near scutellum to beyond humeral callus and backward to just beyond basal third. The margin of the spot is not sharp but the area covered is fairly constant in the series of specimens examined. Under parts not visibly punctured except for the apical abdominal



Figs 1–4 —*Delphastus pusillus* (LeConte) 1, Mandible; 2, maxillary palpus, 3, hind leg; 4, antenna Figs 5–8 —*Catana clauseni*, n sp Figs 9–12 —*Catana parcesetosa* (Sicard) Figs 13–16 —*Catana spilota* (Weise) Figs 17–20 —*Serangium maculigerum* Blackburn Figs 21–24 —*Serangiella flavescens* (Motschulsky)

sternite, which is finely and densely punctured and conspicuously pubescent· Femora shining, impunctate. Middle and hind tibiae with two small denticulations on outer margin at apex of angulation.

Type and 17 paratypes.—U.S.N.M. no. 53941.

Type locality.—Puerto Rico. Type and seven paratypes from Villalba, November 15, 1932, R. G. Oakley (San Juan no. 3195); six paratypes from Rio Piedros, March 19, 1913, T. H. Jones (P.R.S.G.A.Acc. 274–13); one paratype from same locality, January 25, 1914 (P.R.S.G A.Acc. 16–14); one paratype from Barceloneta, March 22, 1932 (San Juan no. 2069); one from Santurce, April 1, 1932 (San Juan no. 2121); and one from Ponce, March 13, 1933, R. G Oakley (San Juan no 3796)

Remarks.—*D. nebulosus* is most closely related to *D. pallidus* (LeConte) but is distinguished from that species by the spot on the elytron and by the smooth and polished side pieces of the metathorax (in *D pallidus* sclerites are finely alutaceous). While *D. pallidus* is known from Cuba as well as from Florida, it is not known from Puerto Rico, and *D nebulosus* is known from Puerto Rico only.

Delphastus collaris, n. sp.

Length 1.3 mm, width 1 0 mm, altitude 0 5 mm. Deep piceous; male with head, entire prothorax, and legs pale yellowish brown, female with head, under part of prothorax, and legs somewhat paler. Integuments shining. Head not very convex, sparsely and irregularly set with a mixture of very fine and moderately coarse punctures, some of which are setigerous. Pronotum slightly more coarsely punctured, very sparsely hairy, anterior angles bent down outside the fine marginal line, which cuts across the angle and which is very fine anteriorly. Scutellum with only two or three punctures. Elytra distinctly and rather densely though not coarsely punctured, sparsely set with erect hairs. Metasternum finely and rather sparsely punctured, the side pieces finely alutaceous. First abdominal sternite punctured as metasternum, second sternite with a complete, third and fourth sternites with an incomplete, row of punctures, fifth sternite finely and sparsely punctured. Femora not visibly punctured Denticles on tibiae elongated into crests as in *D. pusillus* (LeConte).

Type and 37 paratypes.—U.S N.M. no. 53940.

Type locality —Paraiso, Canal Zone. Type and 28 paratypes taken January to March 1911 by E. A. Schwarz; nine paratypes taken March to April 1911 by A. H. Jennings. In addition to the type material I have referred to this species two specimens from Porto Bello, Panama, February 15–24, 1911, E. A. Schwarz; one specimen from Panama City, April 30, 1911, A. H. Jennings; and five specimens from El Cermeno, April–May 1938, J. Zetek (Zetek no 4401).

Remarks.—This species is easily separated from all species of *Delphastus* known to me by the strong punctures on the second to fourth sternites and in the male by the entirely pale prothorax.

Catana, n. gen.

Serangium auct. nec Blackburn, 1889, p. 187.

Coccinellidae of nearly hemispherical form, always slightly longer than greatest width, altitude greater than half the transverse diameter (the three dimensions approaching the ratio 8:7:4). Head convex, eyes relatively coarsely faceted, very slightly emarginate adjacent to antennal sockets, without canthus; distance between inner margins of antennal sockets equal to three-fourths distance between eyes; antennal sockets moderately large, with beaded margin, the marginal bead continuous around the clypeus but finer across anterior margin of clypeus; clypeus transverse anteriorly with rounded angles; antenna 8-segmented, first segment stout, second globular, third elongate, subcylindrical, as long or slightly longer than fourth to seventh combined, fourth longer than fifth, sometimes showing the beginning of a division and therefore morphologically equal to fourth and fifth combined, fifth to seventh short and subequal, eighth long, broad and thin, setigerous, longer than second to seventh combined; mandible with slender apical portion somewhat curved, prostheca conspicuous; maxillary palpus with terminal segment not strongly inflated. Pronotum short, strongly transverse, anterior angles acute and prominent, posterior angles acute, marginal line complete, basal margin slightly sinuate near scutellum Prosternum strongly developed and subtruncate anteriorly, lateral portion deeply notched for reception of antennae, the median portion strongly bicarinate, the carinae strongly divergent anteriorly Posterolateral portions deeply excavate for the reception of the front legs. Mesosternum very short. Metasternum long. All coxae widely separated, the hind coxae especially so. Femora broad, tibiae rather slender, tarsi with four distinct segments, the third about one-third length of fourth. Claws broadly toothed at base. Scutellum small, triangular. Elytra with broad, somewhat concave epipleura, which are impressed deeply for reception of apices of femora. Abdomen of five visible sternites, first and fifth long, second to fourth very short See Figs. 5–16.

Genotype.— *Catana clauseni*, n. sp.

In addition to the type species, I refer the following previously described species to *Catana*: *Serangium parcesetosum* Sicard, 1929, from India, and *Serangium spilotum* Weise, 1913, from Luzon, Philippines

These three species may be distinguished in the following manner:

1. Uniform pale yellow-brown . . *parcesetosa* (Sicard)
   Upper parts deep piceous, elytron with a large castaneous spot 2
2 Pronotum rather densely hairy at sides, spot on elytron elliptical . *spilota* (Weise)
   Pronotum sparsely but evenly hairy; spot on elytron reniform . . . . . . *clauseni*, n. sp

Catana clauseni, n. sp. Figs. 5–8

Cryptognatha sp. Clausen and Berry, 1932, pp. 36–40.

Length 2.3 mm; width 2 mm; altitude 1.14 mm. Head, legs, under parts, and a large reniform spot on each elytron bright castaneous, pronotum, scutellum, and rest of elytron deep piceous. Integuments shining. Front of head minutely and sparsely punctulate, vertex slightly more densely so, a fine hair arising from each puncture. Pronotum more coarsely punctured than head, the punctures sparsely and irregularly set, each furnished with a fine and moderately long hair. Scutellum with a very few fine punctures. Elytra very minutely and sparsely punctulate on disks, slightly more coarsely so on apical third and each with a regular row of fine punctures that is parallel to and near lateral margin, each puncture of the row bearing a short seta. The castaneous reniform spot on each elytron is large, commencing near scutellum and reaching to about apical fourth, its concave margin toward the suture. The spots are variable in size, but in no specimen do they coalesce either anteriorly or posteriorly. Under parts shining and minutely and sparsely punctulate except for the side pieces of the metasternum, which are strongly alutaceous, and for the apical abdominal sternite, which is rather densely punctured and furnished with rather long hairs. Femora finely and rather densely punctulate, hairy, strongly margined on basal half of posterior border. Tibiae slender.

Type and 23 paratypes.—U.S.N.M. no. 53942.

Type locality.—Medan, Sumatra. Other localities: Kuala Lampur, Federated Malay States, and Cuba in the West Indies where the species has been introduced.

Remarks.—The material before me consists of 24 specimens from Medan, seven from Kuala Lampur, both lots collected by C. P. Clausen, and 27 specimens from Cuba, five from Santiago de las Vegas, August 20, 1934, A. R. Otero (E.E.A. Cuba, Ent. no. 10350), and 22 from Camito, Province Habana, May 17, 1938, P. A. Berry. As the species was introduced into Cuba in 1930, the 1938 collection would indicate that it is firmly established on the island. Recently the species has been planted at Nassau, Bahamas, but no recoveries have so far been made from that locality.

Catana spilota (Weise) Figs. 13–16

Serangium spilotum Weise, 1913, p. 241.

The national collection contains a series of 23 specimens collected in May 1911 on Negros Island, Philippines, by C. V. Piper. Although the type locality of this species is Luzon, I can see no reason to doubt the specific identity of the Negros specimens.

Catana parcesetosa (Sicard) Figs. 9–12

Serangium parcesetosum Sicard, 1929, p. 184.

Sixty specimens of this species from India are in the collection. Most of these are labeled "Panjab and U Provinces, VI–X, India, R. S. Woglum"; some carry the additional data "predaceous on Aleyrodidae, Saharanpur, India, R. S. Woglum," and two were taken at Mangalore by J. C. Bridwell. Except for a slight variation in size, the specimens are remarkably uniform.

Serangium Blackburn, 1889

Several species of this genus were studied in connection with the species now placed in *Catana* and those that appear to be new are described in the following pages. For convenience, a key to the new ones, together with two well-known Australian species, is given. For illustration of the salient characters, *Serangium maculigerum* Blackburn was selected, and Figs. 17–20 refer to this species.

Grandi (1914) made a very careful study of an African species, *Serangium giffardi* Grandi, and gave a detailed description with excellent figures of the adult, larva, and pupa. With this evidence there can be no doubt concerning the occurrence of the genus in Africa. It is unfortunate that Grandi was not permitted to dissect a specimen of *Semichnoodes kunowi* Weise and so demonstrate the true affinities of that genus.

1. Elytra densely hairy; front femur alutaceous; side pieces of metasternum roughly sculptured; abdominal sternites strongly punctured . . . . . . *hirtuosum* Blackburn
   Elytra very sparsely hairy, usually with a few setae at base and along margins . . . 2

2. Prosternum alutaceous. 3
Prosternum shining, indistinctly punctured 4
3. Second to fourth abdominal sternites finely strigillose; metasternum without a triangular alutaceous area at side *maculigerum* Blackburn
Second to fourth sternites smooth and polished; metasternum with lateral triangular alutaceous area . *metasternalis*, n. sp
4 Outer face of front femur shining, not evidently alutaceous, pronotum entirely pale *comperei*, n. sp.
Outer face of front femur strongly alutaceous; pronotum at most with pale front angles. 5
5 Abdominal sternites highly polished, without punctures except along apical margin of fifth *bakeri*, n. sp
Abdominal sternites very sparsely but distinctly punctured except fifth, which is rather densely punctured at middle . 6
6. Elytra noticeably and rather strongly punctured *japonicum*, n. sp.
Elytral punctures visible only with high magnification . *luzonicum*, n. sp.

Serangium japonicum, n. sp.

Length 2 mm; width 1.5 mm; altitude 0 9 mm. Deep piceous, head, flanks of pronotum narrowly, and legs pale castaneous. Integuments shining. Head with a few distinct punctures more or less definitely grouped in two patches, one on each side of the median line, sparsely hairy. Pronotum finely, sparsely and very irregularly punctured The punctures near the median line, which is narrowly impunctate, somewhat coarser than those near the lateral margin, surface sparsely hairy. Scutellum occasionally with one or two punctures, usually impunctate Elytra moderately coarsely, densely, and evenly punctured, except that the punctures near the apical angles are somewhat coarser than the others. Elytra without vestiture except for a submarginal row of short setae Epipleura finely punctured and sparsely hairy. Prosternum somewhat rough, meso- and metasternum polished with a few fine punctures, side pieces of metasternum alutaceous Abdominal sternites sparsely punctured except last, which is densely punctured and finely pubescent. Front femora strongly alutaceous, middle and hind femora very sparsely punctured and finely hairy.

Type and 15 paratypes—U S N M. no. 53943

Type locality.—Japan. Type and seven paratypes from Yokohama, where they were found feeding on *Ceroplastes rubens* by S. I Kuwana, three paratypes labeled "Japan. Koebele" (Koebele Note no. 1263); and five paratypes from Nagasaki, taken May 20, 1922, feeding on aleurodid eggs by T. Ishii.

In addition to the type material, I ascribe to this species a single specimen from Nanking, Kiangsu Province, China, taken August 15, 1919, by H. F. Loomis.

Serangium comperei, n. sp.

Length 1.7 mm; width 1.3 mm; altitude 1.1 mm. Pale yellow-brown, pronotum sometimes infuscate at base (female?), elytra piceous except for narrow basal, humeral, and apical margins, which are yellow-brown. Integuments shining. Head finely and very sparsely punctured, the punctures bearing fine, moderately strong setae. Pronotum sparsely and irregularly punctured, the punctures of two sizes, the larger ones bearing fine setae. Scutellum not visibly punctured. Elytra without visible punctures except for a very few in the scutellar region, and one or two setigerous punctures near humeral callus. Epipleura finely and sparsely hairy. Prosternum finely and moderately densely punctured and hairy, meso- and metasternum and abdominal sternites one to four shining, without visible punctures, fifth (apical) sternite shining and impunctate laterally, finely and densely punctured and hairy at middle. Femora shining and not visibly punctured.

Type and four paratypes.—U.S.N M. no. 53944.

Type locality.—Fiji Islands A series of five specimens was taken at the type locality by George Compere in October or November 1899

Serangium bakeri, n. sp.

Length 1 4 mm; width 1.1 mm; altitude 0.6 mm. Under parts, head, and sometimes portion of pronotum castaneous, legs slightly paler than sternites, upper parts generally deep piceous. Head very finely and sparsely punctured Pronotum with a few setigerous punctures, mostly on disk. Scutellum not visibly punctured. Elytra without visible punctures, with a few long setae near scutellum, humeral callus, along basal half of suture, and on lateral margin near apex. Epipleura almost impunctate, apparently not setose. Prosternum very finely and sparsely punctured, mesosternum finely punctate and rather densely hairy, metasternum with setigerous punctures adjacent to mesosternum at middle and on the median portion, side pieces of metasternum together with the narrow side margins of the metasternum proper strongly alutaceous, abdominal sternites highly polished, without punctures except for a few along apical margin. Front femora alutaceous, middle and hind femora finely punctured and sparsely hairy.

Type and paratype. —U S.N.M. no. 53945.

Type locality.— Luzon, Philippine Islands. The type and paratype were taken on Mount Makiling by C. F. Baker. A third specimen that appears to belong to this species was taken at Zamboanga, Mindanao, P I., by Baker.

Serangium luzonicum, n. sp.

Length 2.2 mm; width 1.9 mm; altitude 0 6 mm. Dark castaneous, head and under parts somewhat paler. Head finely, irregularly, and rather sparsely punctured, punctures poorly defined, mostly setigerous. Pronotum with similar though slightly coarser punctures, which are largely wanting along a narrow median longitudinal line, setae sparse and not long, rather more densely set in anterior angles. Scutellum without visible punctures. Elytra distinctly and rather evenly punctured, the punctures very poorly defined, setigerous punctures present across base and in a row parallel to the lateral margin. Epipleura sparsely set with short setae. Prosternum shining, moderately densely punctured and hairy. Mesosternum very short, shining, without visible punctures. Metasternum proper shining, very sparsely set with very fine punctures, which bear short setae, side pieces strongly alutaceous, sparsely hary. Abdominal sternites shining, first four very sparsely set with setigerous punctures, fifth rather densely punctured and hairy Front femora strongly alutaceous, other femora shining, the hind pair moderately densely hairy.

Type and four paratypes.—U.S.N.M. no. 53946.

Type locality.—Luzon, Philippine Islands. Type and one paratype collected at Manila by W. Schultze, two paratypes taken at the same place by George Compere, and one paratype from Bacoor (9 miles south of Manila) taken by P. L. Stangl.

Serangium metasternalis, n. sp.

Length 1.7 mm; width 1.4 mm; altitude 0.6 mm. Dark castaneous to piceous, head and legs paler. Head very finely punctured, the punctures more densely placed toward the clypeal region, where the vestiture of fine hair is rather dense. Pronotum with the punctures coarser than those on head and gathered into two moderately dense patches on each side of the narrow smooth median line. Vestiture sparse and fine. Scutellum not visibly punctured. Elytra sparsely punctured, the punctures visible only under high magnification, without setae except near humeral callus and along lateral margin. Epipleura not visibly punctured. Prosternum evenly and rather strongly alutaceous, very sparsely hairy. Mesosternum smooth at middle, with a small patch of setae at side. Metasternum proper smooth at middle and sparsely and finely punctured; laterally there is a triangular area adjacent to the side piece that, like the side piece itself, is strongly alutaceous. Abdominal sternites one to four finely and sparsely punctured, fifth sternite much more densely punctured and moderately densely hairy. Front femora strongly alutaceous, middle and hind femora smooth and sparsely hairy.

Type and paratype.—U.S N M. no. 53947.

Type locality.—Luzon, Philippine Islands The type and paratype are from Manila, collected by George Compere. With these I have associated a third specimen from Biliran Island, collected by C. F Baker.

Serangiella, n. gen.

Oeneis Motschulsky, 1866, *nec* Mulsant, 1850.
Cryptognatha Crotch, 1874, *nec* Mulsant, 1850.

Coccinellidae similar in form to *Serangium* Head convex, eyes relatively coarsely faceted, slightly emarginate adjacent to antennal sockets, without canthus; distance between inner margins of antennal sockets equal to one-half distance between eyes, antennae sockets strongly transverse, with finely beaded margin, which is apparently not continuous across anterior margin of clypeus, clypeus very short and strongly transverse: antennae 9-segmented, first segment stout, second stout and but little more than half length of first, third strongly obtriangular, a little longer than second and not so long as fourth to eighth combined, these segments becoming successively wider until the eighth, which is almost as wide as the third, ninth segment almost as long as third to eighth combined, width equal to more than half its length; mandible very small, roughly quadrate, the inner or cutting margin feebly curved, the outer margin acutely angulate just before middle of length, prostheca apparently not present; terminal segment of maxillary palpus rather strongly inflated, subtruncate apically. Pronotum short, strongly transverse, anterior angles slightly prominent and strongly rounded, posterior angles acute, marginal line complete though very fine anteriorly. Prosternum strongly developed, truncate anteriorly, deeply notched laterally for reception of antennae, median portion strongly bicarinate, the carinae strongly divergent anteriorly. Mesosternum extremely short. Metasternum long and broad, all coxae widely separated, the hind coxae especially so. Femora broad, middle and hind tibia conspicuously angulate externally beyond middle, tarsi with four distinct segments, the third half as long as but of same diameter as fourth. Claws thickened at base but without distinct tooth. Scutellum small, triangular. Elytra with rather narrow somewhat concave epipleura, impressed for reception of apices of femora. Abdomen of five visible sternites, as in *Catana*.

Genotype.—*Oeneis flavescens* Motschulsky, 1866.

Although I have been able to examine only the one species, I feel reasonably certain that the other two Ceylonese species described by Motschulsky (1866, p. 423), *Oeneis laterale* and *O. nigritulum*, also should be referred to this genus. In fact, it is not evident from the original description that the three species are truly distinct. Figs. 21–24.

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ENTOMOLOGY—*Siphonaptera from Western United States.*[1] IRVING FOX, Iowa State College, Ames, Iowa. (Communicated by C. F. W. MUESEBECK.)

The following descriptions, involving three new species and a new subgenus, are based upon material in the United States National Museum and in the author's private collection. Type material is in the United States National Museum, to whose authorities the author expresses his appreciation for the privilege of studying the collections in their charge. Particular thanks are due to Dr. H. E. Ewing, of the Bureau of Entomology and Plant Quarantine, for his kindness and assistance.

Family HYSTRICHOPSYLLIDAE

Corypsylloides Hubbard

Corypsylloides Hubbard, Pacific Univ. Bull. 37: 7. 1940.

Front reduced; frontal tubercle and notch absent. Gena much enlarged; genal ctenidium obliquely vertical consisting of six spines, the lowermost reduced in width. Eyes absent. Labial palpus 5-segmented, the last segment

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[1] Received February 2, 1940.

tapering distally. Pronotum rounded cephalad, well separated from the head, bearing on the posterior margin a ctenidium consisting of spines of various sizes. Mesopleuron not divided by a vertical rodlike sclerotization into a mesoepisternum and a mesepimeron. Line of division between metepisterna and metepimeron not distinct. Abdominal tergites armed with apical spines but no heavy transverse incrassations. Each abdominal tergite with one row of four bristles, two situated laterally and two dorsally. In male the posterior arm of sternite IX absent; sternite VIII not modified; manubrium laterad to rest of the clasper rather than ventrad to it. Coxa III with a patch of spinelets on the inside. Last segment of each tarsus with four pairs of lateral plantar bristles.

This genus is most closely allied to *Corypsylla* C. Fox from which it may be readily separated by the absence of heavy transverse incrassations on the abdominal tergites and by the character of the genal ctenidium It is easily distinguished from *Nearctopsylla* Rothchild, which it superficially resembles, by the structure of the thorax.

Corypsylloides spinata, n. sp. Figs 1, 2, 4

Male.—Preantennal region of head armed with a frontal row of four bristles and a small bristle at the base of first, third, fourth, and fifth genal spines; several other small bristles located along dorsal margin of head. Spines of genal ctenidium arranged as in Fig. 1. Postantennal region armed with three bristles in addition to a marginal row of about five. Labial palpus barely reaching to apex of fore coxa. Pronotum with a medial row of but three long bristles and a ctenidium of about 15 spines on a side. Mesopleuron with four bristles, two in center and two at posterior margin; metepisternum with two or three bristles, of which one is long and one or two are minute; metepimeron with four bristles. One antepygidial bristle present on a side.

Modified segments.—Process of clasper and movable finger as in Fig. 2. Spring short, not completing a single turn. Total length, 1.8 mm. Greatest depth of abdomen, 0.5 mm.

Female.—A large bristle located on gena near third antennal segment; otherwise, chaetotaxy of head as in male. Pronotal ctenidium consisting of about 13 spines on a side. Two antepygidial bristles present on a side. Receptaculum seminis and sternite VII as in Fig. 4. Total length, 1.9 mm. Greatest depth of abdomen, 0.6 mm.

Type host and type locality.—Meadow mouse, *Microtus townsendii*, at Portland, Oreg.

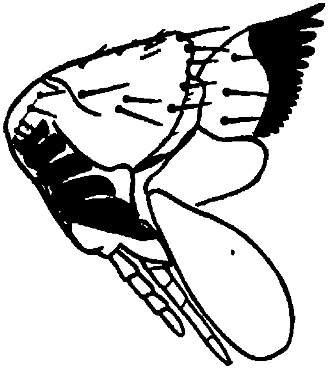
Type slide.—U S.N.M. no. 54011.

Type material.—Male holotype and female allotype collected by S. G. Jewett from *Microtus townsendii*, December 24, 1931, at Portland, Oreg.; in the United States National Museum. Four male and two female paratypes bearing the same data in the author's private collection.

Family DOLICHOPSYLLIDAE

Amphipsylla neotomae, n. sp. Fig. 3

Male.—Frontal tubercle indistinct. Preantennal region of head armed with an ocular row of three bristles, which lies below two bristles located near antennal groove. Postantennal region with a single bristle in addition to a marginal row of about seven. Eye vestigial, the vestiges not pigmented. Labial palpus extending to about three-fourths the length of fore coxa.



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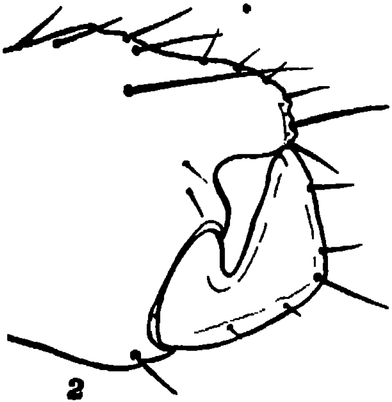

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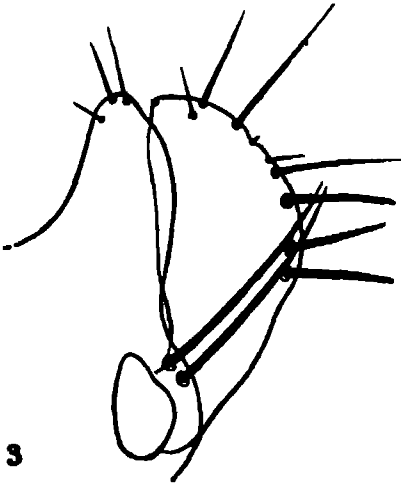

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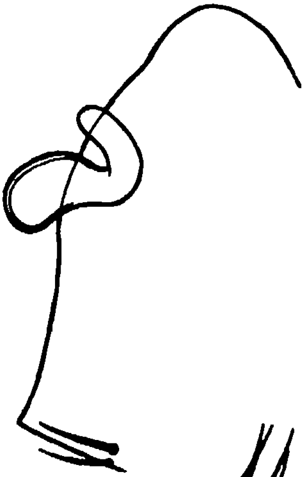

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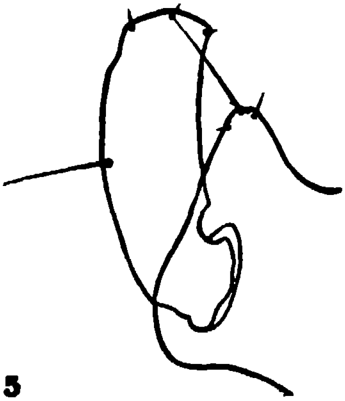

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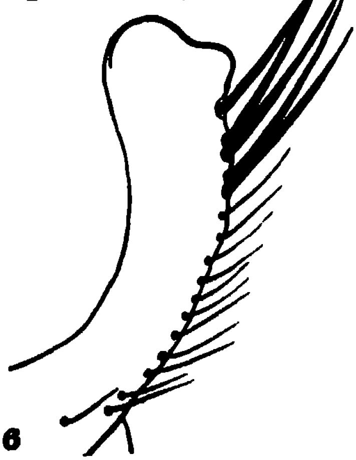

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Fig. 1.—*Corypsylloides spinata*, n. sp., head of male. Fig. 2.—*idem*, process of clasper and movable finger. Fig. 3.—*Amphipsylla neotomae*, n. sp., process of clasper and movable finger. Fig. 4.—*Corypsylloides spinata*, n. sp., receptaculum seminis and sternite VII. Fig. 5.—*Dactylopsylla (Spicata) rara*, n. sp., process of clasper and movable finger. Fig. 6.—*idem*, sternite VIII of male

Pronotal ctenidium with about 13 spines on a side. One long antepygidial bristle between two minute ones present on a side.

Modified segments.—Process of clasper and movable finger as in Fig. 3; the latter armed on posterior margin with three prominent spiniform bristles in addition to several others. Spring short, not completing a single turn. Total length, 3.4 mm. Greatest depth of abdomen, 1.1 mm.

Type host and type locality—Wood rat, *Neotoma desertorum*, at Dos Palos, Calif.

Type slide.—U.S.N.M. no. 54012

Type material.—Male holotype collected by H. S. Gentry from *Neotoma desertorum*, March 1934, at Dos Palos, Calif.; in U. S. National Museum.

But two members of this genus have heretofore been reported from North America, *A. sibirica pollionis* Rothschild from Alberta and *A. ewingi* I Fox from Alaska. The above described new species may be separated from both of these by the structure of the male genitalia It represents the first record of the occurrence of the genus *Amphipsylla* within the United States.

Genus DACTYLOPSYLLA Jordan

Spicata, n. subgen.

Frontal tubercle prominent, not acuminate. Eye vestigial, the vestiges indistinct. Pronotum armed with a ctenidium of long slender spines. In male sternite VIII broad and prominent, armed on the posterior margin with a number of bristles of which some are robust and heavily pigmented (Fig. 6). Anterior arm of sternite IX much narrower than in *Dactylopsylla* (*Dactylopsylla*) Manubrium not short and triangular, tapering and curved distally.

Type species—*Dactylopsylla* (*Spicata*) *rara*, n sp

This new subgenus may be readily distinguished from *Dactylopsylla* (*Dactylopsylla*) and from *Foxella* Wagner by the structure of the male genitalia. In the type subgenus sternite VIII is large but not armed with heavy pigmented bristles. In *Foxella* this sternite is small and bears but a single long bristle near the apex. The manubrium of the new subgenus, being narrow and tapering distally, is markedly different from both *Foxella* and *Dactylopsylla* (*Dactylopsylla*) where this structure is short, broad, and triangular.

Dactylopsylla (Spicata) rara, n. sp. Figs. 5, 6

Male.—Preantennal region of head armed with two rows of bristles; the upper row consisting of about five, the lower row of four Eye vestigial, the vestiges exceedingly small and inconspicuous Postantennal region of head armed with a marginal row of six or seven bristles. Labial palpus extending beyond basal half of fore coxa. Pronotal ctenidium consisting of about 14 spines on a side.

Modified segments.—Movable finger and process as in Fig. 5; the former differing in structure on the two sides. In one case the movable finger is armed with one bristle on the posterior margin (Fig. 5), while in the other it is armed with three bristles and there are slight differences in the shape of the structure. Posterior arm of sternite IX with a number of small bristles distally. Sternite VIII broad, wider distally and armed on posterior margin with five or six heavily pigmented bristles and about a dozen much more slender ones. Total length, 4.5 mm. Greatest depth of abdomen, 1.5 mm

Type host and type locality.—Pocket gopher, *Thomomys fossor*, Jackson County, Colo.

Type slide.—U.S.N.M. no. 54013.

Type material.—Male holotype collected by S. C. McCampbell from *Thomomys fossor* in Jackson County, Colo., July 13, 1926; in the United States National Museum.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE ACADEMY

359TH MEETING OF THE BOARD OF MANAGERS

The 359th meeting of the Board of Managers was held in the Board Room of the Cosmos Club on Friday, February 9, 1940. President CRITTENDEN called the meeting to order at 8:00 P.M.

The attendance was as follows:

E. C. CRITTENDEN
F. D. ROSSINI
F C. KRACEK
H. S RAPPLEYE
J H. HIBBEN
G STEINER
J E GRAF
W B. BELL
A. T MCPHERSON
A H CLARK
A WETMORE
F O. COE
C. THOM
P C WHITNEY
H L. CURTIS
E W. PRICE
C L. GARNER
H G DORSEY
C L GAZIN
W W. DIEHL

and by invitation: H B COLLINS, JR, and J. H KEMPTON.

The following budget was adopted for 1940:

Secretary's Office	$ 450 00
Treasurer's Office	225 00
Meeting's Committee	350 00
Membership Committee	10 00
Executive Committee	10 00
Custodian of Publications	120 00
Journal	2,500.00 plus receipts
Total. . . .	$3,665 00 plus Journal receipts

In addition to the reports of standing committees the Board received a petition signed by L. B. TUCKERMAN, O. E MEINZER, W. J. HUMPHREYS, W. RAMBERG, C. THOM, and P. A. SMITH requesting a change in the bylaws restoring the offices of the two nonresident Vice-presidents eliminated by ballot January 9, 1940. The President appointed a special committee to consider this petition and make recommendations to the Board. This Committee has as its chairman H. L. CURTIS, with CHARLES THOM and P. C. WHITNEY as members.

The Board considered the nature of the ceremonies to be held in connection with the presentations of the Awards for Scientific Achievement and instructed the Committee on Meetings to make the necessary arrangements.

On recommendation of the Editors of the Journal, the Board authorized the President to appoint a committee to investigate the present status of the contract for printing the Journal and, if in their judgment advisable, to solicit bids for printing the Journal in 1941. The President appointed F. G. BRICKWEDDE chairman of this committee, with H. G AVERS, R. W. BROWN, C. L. GAZIN, J. H. KEMPTON, R J. SEEGER, and J. A. STEVENSON members.

The meeting adjourned at 10:52 P.M.

JOURNAL
OF THE
WASHINGTON ACADEMY OF SCIENCES

VOL 30 JULY 15, 1940 No 7

CHEMISTRY —*The separation of isotopes by chemical means*[1]

HAROLD C UREY, Columbia University (Communicated by FRED L MOHLER)

Ten years ago no successful separation or even extensive concentration of the isotopes of any of the elements had been made Methods for the separation of isotopes that had been suggested and investigated depended upon differences in the physical properties of isotopes and isotopic compounds which were readily predictable from simple kinetic theory, as, for example separation by diffusion through porous tubes and by unidirectional evaporation Today several methods are available for the concentration of isotopes, and the isotopes of a few elements have been separated quite completely It is my purpose here to review the present status of this problem, and particularly to emphasize the part of the problem with which my colleagues and I have been most closely associated

In 1931 two successful attempts at the partial separation of isotopes were made The first of these, by Keesom and van Dijk,[2] dealt with the separation of the isotopes of neon by the fractional distillation of liquid neon The second of these was the concentration of the rare isotope of hydrogen by Brickwedde, Murphy, and myself,[3] in connection with our experiments leading to the discovery of this isotope These distillation methods could be predicted from current theories in regard to the solid state and were independently predicted by these two groups of authors Recent work by Keesom, van Dijk, and Haantjes[4] has produced rather high concentrations of the neon isotopes in substantial amounts, and Scott and Brickwedde[5] have prepared hydrogen deuteride, HD, in nearly a pure form by the fractional distillation of a mixture of hydrogen, deuterium, and hydrogen deuteride

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[1] The Tenth Joseph Henry Lecture of the Philosophical Society of Washington, delivered on March 16, 1940 Received April 19, 1940

[2] KEESOM, W H and VAN DIJK, H Proc Acad Sci Amsterdam 34 42 1931

[3] UREY H C, BRICKWEDDE, F G and MURPHY, G M Phys Rev 40 1 1932

[4] KEESOM, W H, VAN DIJK H, and HAANTJES J Proc Acad Sci Amsterdam 37 615 1934, Physica 1 1109 1934

[5] SCOTT, R B and BRICKWEDDE, F G Phys Rev 48 483 1935

Differences in vapor pressures of deuterium and protium oxides, the O^{16} and O^{18} waters, and the N^{14} and N^{15} ammonias, as well as similar differences in the cases of many of the isotopic compounds of hydrogen, are now known and have been used to concentrate the isotopes of oxygen and hydrogen by fractional distillation methods. These differences in vapor pressures are small, and effective separation can be made only by very efficient fractionation columns.

The first complete separation of isotopes was accomplished by means of the electrolytic separation of the hydrogen isotopes, discovered by Washburn.[6] This method of separation is so effective and so easily carried out, and the demand for the heavy isotope of hydrogen so general, that deuterium and its compounds are now produced commercially by this method.

In 1932 Hertz[7] developed his cascade diffusion method, making use of a series of diffusers arranged in a cascade, so that the light fractions diffusing through the porous tubes, or through a moving stream of mercury vapor, were fed to a preceding unit of the cascade, while the heavy fractions were fed to the following unit of the cascade. In this way Hertz prepared nearly pure neon isotopes and also succeeded in preparing very pure samples of deuterium. Others have used this method to concentrate other isotopic substances.

In 1935, Urey and Greiff[8] presented a method for the separation of isotopes by chemical means, depending upon the slight differences in the chemical properties of isotopic compounds. This method has since been developed and has led to the separation of nitrogen and carbon isotopes in substantial amounts.

Recently Clusius and Dickel[9] discovered the thermal diffusion method, which is applicable to many gaseous substances. The method has many interesting features and undoubtedly can be used widely for the separation of small amounts of rarer isotopes.

Recently Beams[10] has made some orienting experiments on the centrifugal fractionation column method. These have not gone so far as to produce separated isotopes, but they have demonstrated the feasibility of the method.

Smith and Scott[11] have investigated the possibility of using oscillating electric fields acting upon streams of ions as a means of separating isotopes. The difficulty of mass spectrographic methods and these alternating field methods resides in the low intensity of beams of ions. Owing to the repulsion between the ions, the beams spread rapidly, and sharp separation can not be secured if large amounts of the separated isotopes are desired. Smith has found that it is possible to arrange an apparatus so that electrons are present in the beam with the ions, thus preventing the spread of the beam.

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[6] WASHBURN, E. W., and UREY, H C , Proc Nat Acad Sci. 18: 496. 1932.

[7] HERTZ, G. Zeit Phys. 79: 108, 700. 1932.

[8] UREY, H C , and GREIFF, L. J. Journ Amer. Chem Soc 57: 321 1935.

[9] CLUSIUS, K , and DICKEL, G. Naturwissenschaften 26: 546. 1938.

[10] BEAMS, J W , and SKARSTROM, C. Phys. Rev 56: 266. 1939.

[11] SMITH, L. P , and SCOTT, G. W , Jr. Phys Rev. 55: 946. 1939.

With all these methods available, or their development actively in progress, it appears now that the separation of the isotopes of the elements in amounts necessary for adequate physical, chemical, and biochemical research is only a matter of time. The past 10 years have brought the problem from a position where no separation had been secured to a point where the entire discussion is now based upon the best methods. The methods that my colleagues and I have developed, namely, the chemical exchange methods and distillation methods, appear to be those most suitable for large production of separated isotopes in the limited number of cases where they are applicable. It is the purpose of this lecture to discuss principally these chemical methods of separation for the elements carbon, nitrogen, and sulphur, and to compare this method with the others mentioned above.

THEORY OF THE SEPARATION OF ISOTOPES BY FRACTIONATION COLUMNS

The most common method for the separation and purification of substances used in chemistry is that of distillation, making use of fractionation columns. As mentioned before, this method was used for the concentration of the hydrogen and neon isotopes where the differences in vapor pressures could be readily predicted by the use of the Debye theory of the solid state. Early in the investigation of the properties of hydrogen and deuterium compounds, Lewis and Cornish[12] and Washburn, Smith, and Frandsen[13] observed that there were differences in the vapor pressures of hydrogen oxide and deuterium oxide, and it was also observed that there were slight differences in the vapor pressures of the O^{16} and O^{18} waters.

The theory of distillation apparatus has been discussed in standard textbooks for many years, and little new can be added. However, there are certain points to be emphasized when one comes to the fractional distillation of substances with only slight differences in vapor pressures. The simple process fractionation factor may be defined as the ratio of the two constituents in the vapor divided by this ratio in the liquid phase. Letting N and n represent the mole fraction of one constituent in the liquid and the vapor, respectively, this fractionation factor α may be defined by the equation

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[12] Lewis, G. N., and Cornish, R. E. Journ. Amer. Chem. Soc 55: 2616. 1933.

[13] Washburn, E. W., Smith, E. R., and Frandsen, M. Bur. Standards Journ. Res. 11: 453. 1933.

$$\frac{n}{1-n} \bigg/ \frac{N}{1-N} = \alpha. \tag{1}$$

The fractionation secured by a column is then given, according to reasonable theory (see below) as well as experiment, by the formula

$$\frac{N_t}{1-N_t} \bigg/ \frac{N_b}{1-N_b} = \alpha^{kz}, \tag{2}$$

where N_t and N_b are the mole fractions of one constituent at the top and bottom, respectively, α is the simple process fractionation factor defined above, z is the length of the column and k is a constant. The quantity kz is referred to as the number of theoretical plates. In the case of the plate columns, common for many distillation processes in the chemical industry, the plates are actual physical plates, although each may not change the ratio of the two constituents by the simple process factor. In the case of packed columns, which have been developed in recent years in considerable variety, no physical plates are present in the column but the fractionation follows this exponential form, as determined by experiment. It is of considerable interest to derive expressions by which the time required for equilibrium to be established can be calculated at least approximately. Such a calculation was made by Huffman and Urey[14] for the case of total reflux with a large reservoir at one end of the column. The formula secured by them is

$$N_0 ln\frac{N_0}{N} + (1 - N_0) ln\frac{1 - N_0}{1 - N} = \left(\frac{LN_0(\alpha - 1)kz\, ln\alpha}{H}\right)t \tag{3}$$

where H is the holdup of the column per unit length, N and N_0 are the mole fractions of one constituent at the reflux end at time t, and in the natural substance, respectively, and L is the rate of flow through the column. This formula shows that in order to secure a rapid equilibrium, a small holdup, large natural abundance, rapid rate of flow, and a fractionation factor that deviates markedly from unity, are required. In the distillation of isotopic substances and their separation by chemical exchange methods, however, the value of the simple process factor is very nearly unity, and the time required to reach a steady state may be very long indeed unless a column of proper design is secured. This means that columns with small holdup, rapid rate of flow, and a large number of theoretical plates per unit length are required. In most industrial processes, fractionation columns that have from 10 to 50 theoretical plates are quite adequate. However, if adequate separation is to be secured for isotopic molecules, a very large number of theoretical plates, e.g., from 300 to 500, is required. This large number is necessary because the ratios of vapor pressures of isotopic substances deviate only slightly from unity.

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[14] Huffman, J R, and Urey, H. C. Ind. Eng. Chem. 29: 531. 1937.

The transport of such apparatus is, of course, equal to the difference in the flow of one isotopic substance in the two directions. If the mole fraction of the isotope to be concentrated is small, the transport at the beginning of the operation of such a column, using total reflux, is given by the equation

$$T = LN_0(\alpha - 1) \tag{4}$$

where L is the total flow in either direction and N_0 the mole fraction of the rare isotope in the mixture. This formula is approximate and applies only when the fractionation column is not near the steady state.

A more exact theory of the operation of such columns can be given if one assumes that back diffusion is not an important process in the column, and that the rate of transport of material from the one phase to the other depends upon the concentrations in the two phases in the way required for the equilibrium process. Two differential equations can be secured for the rate of change of concentration in the two phases. These are:

$$H\frac{\partial N}{\partial t} - L\frac{\partial N}{\partial z} - k_1N(l - n) + k_{-1}n(l - N) = 0 \tag{5}$$

$$h\frac{\partial n}{\partial t} + l\frac{\partial n}{\partial z} + k_1N(l - n) - k_{-1}n(l - N) = 0 \tag{6}$$

where L, H, N and l,h,n are the rate of flow, the holdup, and the mole fraction in the liquid and gas phase, respectively, and k_1 and k_{-1} are the velocity constants for the transport of this isotope from one phase to the other. The solutions of these two simultaneous equations in a form suitable for convenient calculation have not been made. However, if we are interested only in the final steady state, so that the derivatives with respect to the time are zero, the solution of the equations is simple. The first integral is

$$LN - ln = n_0(L - l) \tag{7}$$

This equation states that the net flow in the column is equal to the amount of material withdrawn at one end of the column. The second integral leads to the following relation between the forward flow and the composition of the material produced:

$$y + \theta = (l + \theta y) \tan h \left\{ -\sigma(l + \theta y) + \tan h^{-1} \left(\frac{1 - 2N_0 + \theta}{1 + \theta y} \right) \right\} \qquad (8)$$

where $y = l - 2n_0,\ \theta = \dfrac{l - L}{l - \alpha},$ and $\sigma = \tfrac{1}{2} lnF_0.$

In these equations n_0 is the mole fraction of the isotope in the forward flow and F_0 is the overall fractionation factor when the forward flow is zero. By making use of these equations it is possible to show how the effective fractionation factor for the column changes with the rate at which material is withdrawn. Our apparatus seems to give better results than the simple theory would indicate.

In the case of the fractional distillation of the hydrogen isotopes, the values of α are in the neighborhood of from 3 to 10, depending upon the temperature and whether one is working with H_2 and HD or H_2 and D_2. The distillation of the hydrogens is therefore a problem like that of the separation of ordinary substances, except that the fractionation must take place at a very low temperature. In the case of the fractionation of the hydrogen and deuterium oxides, however, or of the O^{16} and O^{18} waters, the ratios of the vapor pressures are nearly equal to unity, as shown in Table 1. In this case it may require long periods of time for the fractionation column to come to a steady state.

TABLE 1 —RATIO OF VAPOR PRESSURES OF WATERS

T °C	$p(H_2O^{16})/(pH_2O^{18})$	$p(H_2O)/p(D_2O)$
3 8		1 188
11 25	1 013	
20 0		1 148
23 0	1 008[6]	
35 6	1 008[8]	
40 0		1 115
46 35	1 007[7]	
80.0		1 070
100 0	1 003 (extrapolated)	1 052

CONCENTRATION OF OXYGEN ISOTOPES

Huffman and Urey[14] made a substantial concentration of the O^{18} isotope by means of distillation methods. Water was pumped in at the top of a fractionation column at a fixed rate, evaporated completely at the bottom, and the vapor returned upward through the column. At the top, the vapor was discarded since it was not convenient to condense the water for re-use. In this way water containing 0.85 per cent O^{18} was produced, i.e., with somewhat over four times the natural concentration of O^{18}. Also, considerable amounts of water containing half the normal abundance of O^{18} were produced by boiling a large container of water at the bottom of the column and totally refluxing at the top. The operation of the column in this case was not steady and this probably accounts for the smaller change in the ratio secured.

It does not seem probable that distillation methods can be very useful in other cases for the separation of isotopic substances. The N^{14} and N^{15} ammonias have but slight differences in their vapor pressures, as is shown by Table 2. The great difficulty in carrying out a distillation at the temperature of boiling ammonia, using extensive fractionation columns, makes this an unsatisfactory way for the fractionation of isotopes. A study of the vapor pressures of the hydrogen and deuterium oxides shows that there is a marked difference of vapor pressure even at the critical temperature of water, i.e., as the temperature increases, differences in vapor pressures do not necessarily at once become small. The same may be true in the case of the ammonias, and the question deserves further study to determine whether a fractionation column at ordinary temperatures, operating under pressure, might not produce a considerable fractionation of the nitrogen isotopes. A similar behavior might be observed in other cases, but as yet our knowledge of this subject is incomplete.

TABLE 2 —VAPOR PRESSURES OF THE AMMONIAS

T °K	$pN^{14}H_3$ (cm of Hg)	$pN^{15}H_3$ (cm of Hg)	$p(N^{14}H_3)/p(N^{15}H_3)$
197 75	5 488	5 459	1 0053
204 4	9 060	9 018	1 0046
207 1	10 904	10 858	1 0042
208.8	12 593	12 541	1 0041
217 2	21 570	21 488	1 0038
228 2	41 030	40 899	1 0032
228 4	41 550	41 418	1.0032
234 9	59 560	59 399	1 0027
239 4	75 340	75 153	1 0025

CHEMICAL EXCHANGE REACTIONS

The discovery of the isotope of hydrogen and the very extensive studies that have been made of the differences in chemical properties of hydrogen, deuterium, and their compounds show that the chemical properties of isotopic compounds are not identical, and that slight but definite differences may be expected. The first calculation of such differences in chemical properties, made by Urey and Rittenberg[15] on the hydrogen-hydrogen iodide exchange reaction, showed again that marked differences could be expected. Subsequent calculations and experiments by many workers show that even larger differences in the chemical properties are present in many other cases, as, for example, in the exchange reaction between hydrogen and water. This work naturally led to a calculation of the equilibrium constants for exchange reactions involving other isotopes. The results of such calculations are given in Table 3. These calculations are from Urey and Greiff[8]

TABLE 3.—EQUILIBRIUM CONSTANTS OF GASEOUS EXCHANGE REACTIONS

Reaction	Equilibrium constant (α) 298 1 °K
$\frac{1}{2}SO_2^{16}+H_2O^{18}=\frac{1}{2}SO_2^{18}+H_2O^{16}$	1.028
$\frac{1}{2}CO_2^{16}+H_2O^{18}=\frac{1}{2}CO_2^{18}+H_2O^{16}$	1 054
$\frac{1}{2}O_2^{16}+H_2O^{18}=\frac{1}{2}O_2^{18}+H_2O^{16}$	1 020
$C^{13}O+C^{12}O_2=C^{12}O+C^{13}O_2$	1 086
$\frac{1}{2}Cl_2^{35}+HCl^{37}=\frac{1}{2}Cl_2^{37}+HCl^{35}$	1 003
$\frac{1}{2}Br_2^{79}+HBr^{81}=\frac{1}{2}Br_2^{81}+HBr^{79}$	1 0004
$\frac{1}{2}N_2^{14}+N^{15}O=\frac{1}{2}N_2^{15}+N^{14}O$	1 015
$Li^6H+Li^7=Li^7H+Li^6$	1 025
$Cl^{35}O_2+\frac{1}{2}Cl_2^{37}=Cl^{37}O_2+\frac{1}{2}Cl_2^{35}$	1 023
$Cl^{35}O_2+HCl^{37}=Cl^{37}O_2+HCl^{35}$	1 027

with the exception of the last two equilibria recorded, which were made by Dwayne T. Vier. These fractionation factors, α, deviate from unity by as much as 9 per cent in one case. The table shows that somewhat larger deviations from unity are obtained in the case of elements of low atomic weight than in the case of those of high atomic weight, but that even for elements as heavy as chlorine, a considerable fractionation may be expected. The calculations given in these tables are made by the use of well-established statistical mechanical theory, using experimental molecular spectra data for abundant molecules. The necessary vibration frequencies and moments of inertia for the rarer molecules are calculated by the use of the theory of small vibrations applied to molecules of this kind.

Exchange reactions involving two phases must be considered if countercurrent methods similar to distillation, using a fractionation column, are to be used. In the case of the liquid-gas phase equilibria the examples listed in Table 4 may be considered. The calculated val-

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[15] UREY, H. C., and RITTENBERG, D. Journ. Chem. Phys. 1: 137. 1933; 2: 106. 1934.

TABLE 4.—EQUILIBRIUM CONSTANTS OF TWO PHASE EXCHANGE REACTIONS

Reaction	Equilibrium constant calculated	Equilibrium constant observed
$N^{15}H_3(g)+N^{14}H_4^+(aq)=N^{14}H_3(g)+N^{15}H_4^+(aq)$	1 033	1 023
$HC^{12}N(g)+C^{13}N^-(aq)=HC^{13}N(g)+C^{12}N^-(aq)$	1 026	1 013
$HCN^{14}(g)+CN^{15-}(aq)=HCN^{15}(g)+CN^{14-}(aq)$	1 003	Slightly less than 1
$S^{34}O_2(g)+HS^{32}O_3^-(aq)=S^{32}O_2(g)+HS^{34}O_3^-(aq)$	—	>1

ues of the equilibrium constants, which are also the values of the fractionation factors, α, have been secured by assuming that the distribution functions for the ions in solution are the same as those to be expected for a gas. Such calculations can not be exact, but experiment does show rather good agreement with the calculated values recorded in the second column of the table. The observed values depend upon our experiments made on the separation of the isotopes of carbon, nitrogen, and sulphur, and depend upon the rate of production of the heavy isotopes, assuming that equation (4) applies. Since our separation apparatus is run under conditions where this formula may give too low a value for the fractionation factor, and since experiments of this kind never run perfectly, the observed constants as given deviate less from unity than actually is the case. This is due to the fact that the transport is proportional to the deviation from unity of this constant, and any interruption of the process is likely to decrease the yield, and can not increase the yield under any circumstances. The table shows that the values calculated in this way are at least a good approximation to the experimental values.

Exchange reactions involving two liquid phases have been used by Lewis and MacDonald[16] to secure a partial separation of the lithium isotopes. The exchange reaction involved is given as the first reaction in Table 5. Exchange reactions between solid and liquid phase systems are illustrated by the last three equations of Table 5. In these cases it is impossible to make satisfactory calculations of the equilibrium constants, and only the constant observed by Taylor and Urey[17] in one case, namely, the lithium ion-lithium zeolite exchange reaction is recorded. In the potassium ion-potassium zeolite and the ammonium ion-ammonium zeolite reactions, only the direction of the deviation of the constant from unity can be given, and it seems difficult to deduce from the results of Lewis and MacDonald any value for the equilibrium constant for their exchange reaction.

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[16] LEWIS, G. N., and MACDONALD, R. T. Journ. Amer. Chem. Soc. 58: 2519. 1936.

[17] TAYLOR, T. I., and UREY, H. C. Journ. Chem. Phys. 6: 429. 1938.

TABLE 5.—EQUILIBRIUM CONSTANTS OF ZEOLITE EXCHANGE REACTIONS

Reaction[1]	Equilibrium constant observed
Li^7 (amalgam) $+ Li^{6+} = Li^6$ (amalgam) $+ Li^{7+}$	>1
$Li^{6+} + Li^7Z = Li^{7+} + Li^6Z$	1 022
$K^{39+} + K^{41}Z = K^{41+} + K^{39}Z$.	<1
$N^{14}H_4^+ + N^{15}H_4Z = N^{15}H_4^+ + N^{14}H_4Z$	<1

[1] The zeolite radical is indicated by the symbol Z

Such two phase exchange reactions can be used for the separation of isotopes, and the effect of the simple process fractionation in the case of gas-liquid equilibria can be multiplied many times by the use of countercurrent apparatus of the distillation column type. In the case of liquid-liquid equilibria, countercurrent liquid flow can be used in a similar way, but in the case of the liquid-solid equilibria, a countercurrent flow of this kind would be very difficult to maintain. In this latter case, procedures similar to those of chromatographic analysis can be used effectively.

The apparatus which has been used by my colleagues and myself for the fractionation of the nitrogen, carbon, and sulphur isotopes consists of the packed column type of fractionation column. The time which is required for such apparatus to come to a steady state may be very long indeed, and in the experiments which we have conducted years would have been required in some cases if special types of operation had not been employed. The transport of the column is given approximately by equation (4), and this shows that the transport is proportional to the total flow in the column and to the concentration of the less abundant material, provided that the mole fraction of this less abundant material is small. Thus if one fractionation column will increase the concentration by some factor, F, the total flow could be decreased in the next column by the same amount and still the transport would remain the same. Therefore a second column is made to operate on the product of the first, the second column having a smaller total flow and a smaller hold up, and hence the final steady state is reached in a much shorter time than if this additional fractionation had been carried out with the column of the same size as the first one. In this way the steady state is reached much more quickly, with the same transport. A third still smaller column can now be used to operate on the product of the second in a similar way.

Fig. 1 shows diagrammatically the arrangement of the apparatus which we have used for the concentration of the nitrogen isotopes.[18] In this case the heavy isotope concentrates in the liquid phase. An ammonium-nitrate solution containing 60 per cent by weight of the salt was pumped into the top of the first unit. This unit increased the concentration of N^{15} by a factor of about 7. Six-sevenths of the material was withdrawn at the bottom, sodium hydroxide added, and the ammonia removed from the solution by boiling and passed back upward through this unit. One-seventh of the material flowed to Unit 2, which changed the concentration of the nitrogen isotopes by an additional factor of 9. About eight-ninths of the material was removed

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[18] THODE, H. G., and UREY, H. C. Journ. Chem. Phys. 7: 34. 1939.

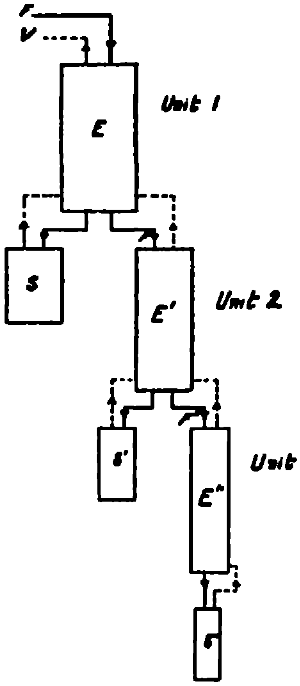

Fig. 1.—Arrangement of fractionation units (*E*, *E'*, *E''*) in nitrogen apparatus. Stripping units are indicated by *S*, *S'* and *S''*, liquid flow by solid lines (*F*), and gas flow by broken lines (*V*)

at the bottom of this column, sodium hydroxide added, and the ammonia sent upward through the unit, while one-ninth went to Unit 3, which further changed the ratio of the nitrogen isotopes by a factor of 11. The ammonia was finally liberated at the bottom, passed upward through all the units, as indicated by the arrows, and finally absorbed in water at the top of Unit 1. The arrangement is similar to a distillation apparatus except that a large reservoir of material is maintained at the top of the first unit and total reflux at the bottom. The solution takes the place of the liquid in a distillation apparatus, and the ammonia gas replaces the vapor in distillation. Rapid exchange takes place between the ammonium ion and ammonia just as equilibrium is maintained between the liquid and the gas in a distillation.

The arrangement used in the carbon case[19] is illustrated in Fig. 2. Only two units were used since we make use of hydrogen cyanide and not too large quantities could be used in a laboratory building. In this case, C^{13} concentrates in the gas phase and therefore the general arrangements must be inverted as compared with the nitrogen separation. Solutions of sodium cyanide and sulphuric acid are pumped into the bottom of Unit 1 and the hydrogen cyanide removed from the solution by a stripping column. Hydrogen cyanide gas rises through Unit 1. At the top, sufficient sodium hydroxide (free of iron) is added to absorb about four-fifths of the hydrogen cyanide. This unit changes the ratio of the carbon isotopes by a factor of about 5. The remainder

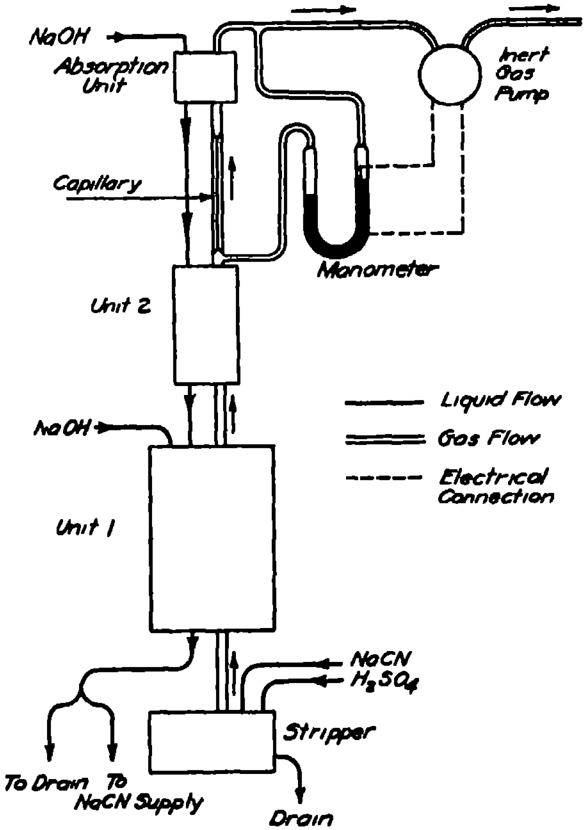

Fig. 2.—Arrangement of fractionation units in the carbon apparatus.

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[19] Hutchison, C. A., Stewart, D. W., and Urey, H. C. Journ. Chem. Phys. In press.

of the hydrogen cyanide gas passes to the bottom of Unit 2, and at the top of Unit 2 sufficient sodium hydroxide is added to absorb it. This second unit changes the ratio of the carbon isotopes by approximately a factor of 6.

Small amounts of air are introduced into the apparatus with the solutions, and if these are not removed from the top of the second unit the air will accumulate there and prevent the hydrogen cyanide from reaching the top of this unit. As time went on the apparatus would completely fill with air, and no fractionation would be obtained since all absorption of the hydrogen cyanide would occur at the bottom of the first unit. To avoid this it is necessary to remove the inert gas at the top of the second unit. This is done by connecting an additional absorbing unit with the top of Unit 2 by a capillary tube. The sodium hydroxide is pumped first to the absorbing unit and from the bottom of this to the top of Unit 2. Part of the HCN is neutralized in the absorbing unit and the remainder at the top of Unit 2. As the inert gas accumulates at the top of the absorbing unit, the flow of hydrogen cyanide through the capillary decreases. A manometer arranged with an electrical contact is attached to the ends of the capillary so that the pressure difference measures the rate of flow of HCN. When the pressure difference falls to zero, a pump is started which removes inert gas from the top of the absorbing unit. This causes rapid absorption of HCN in the absorbing unit again, and the pressure drop across the capillary is restored. In this way inert gas is removed automatically without difficulty.

The apparatus is controlled by fixing the rates with which alkali enters the tops of the two units. The rate of supply of hydrogen cyanide at the bottom is regulated by maintaining a constant pressure at this point through a manometer with an electrical contact which starts and stops the feed pump.

The actual form of the apparatus is illustrated in Fig. 3 for the case of the nitrogen separation. Only the two smaller units are used for the carbon separation. A detailed description of this apparatus has been published elsewhere.[18]

Taylor and Urey[17] have made use of the liquid-solid equilibria to effect a change in the ratio of the lithium, potassium, and nitrogen isotopes. In these cases a 30-foot tube was filled with a zeolite, say, for example, a sodium zeolite and covered with a solution of sodium chloride. Lithium chloride solution was then fed into the top of the tube and the solution withdrawn at the bottom. Since lithium 6 is concentrated in the zeolite rather than in the lithium chloride solution, it is retarded relative to lithium 7 in its movement down the column. After some time the solution leaving the bottom of the column will contain lithium ion and this will be enriched in lithium 7; that is, the leading sample contains the heavier lithium. One can then wash out the lithium chloride from the zeolite and in this case the trailing sample is enriched in lithium 6. Fig. 4 represents results secured in such experiments by Taylor. A rather marked change in the relative abundance of lithium is secured by this simple method. Similar experiments using potassium and ammonium salts showed that changes in the relative

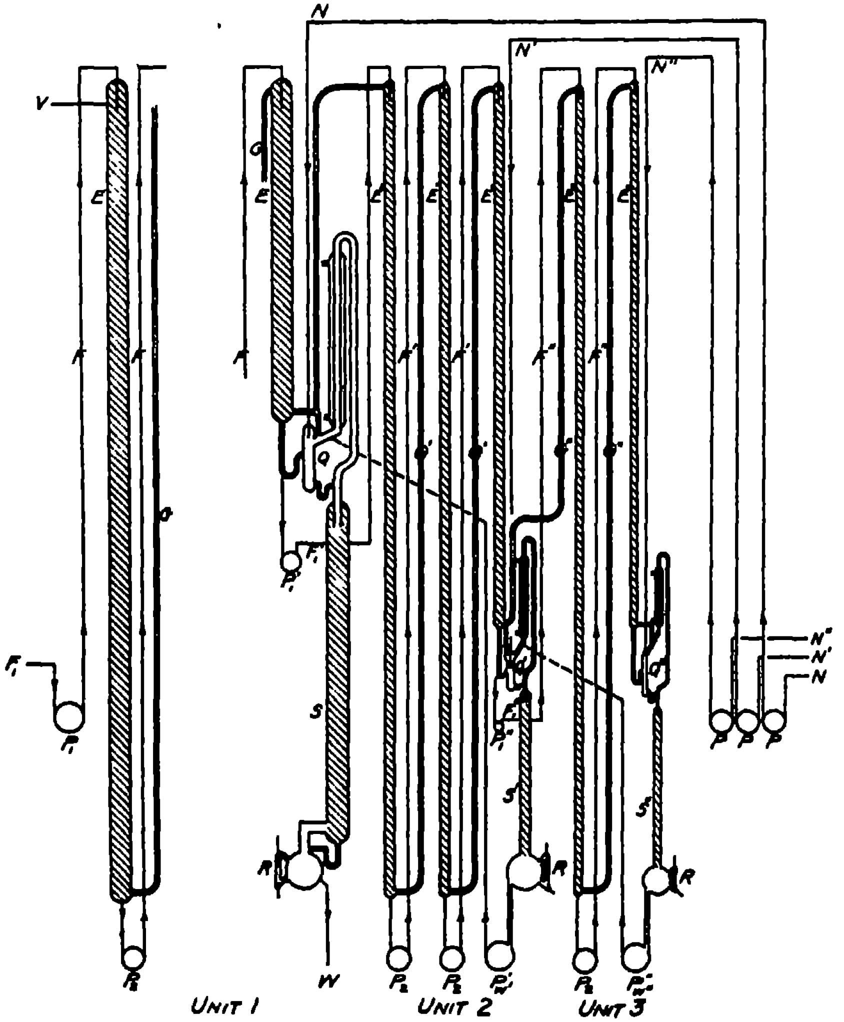

Fig. 3.—Complete apparatus as used in the separation of the nitrogen isotopes.

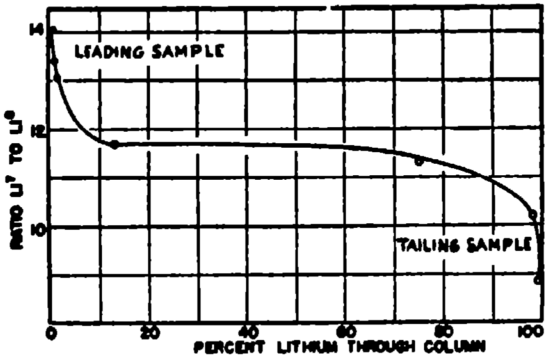

Fig 4—Distribution of lithium isotopes coming through a zeolite column

abundances of the isotopes of potassium and nitrogen result from such experiments, but that the heavier isotopes are concentrated in the trailing samples in these cases.

CRITIQUE OF SEPARATION METHODS

In considering the relative advantages of various methods for the separation of isotopes, several factors must be kept in mind. In the first place there is the question of the amounts of isotopic materials that are required for experiments. For effective work most chemical experiments require amounts of the order of grams of these separated isotopes. In the second place, the cost of production is an important item. If one is separating only small amounts as a laboratory curiosity or for a very few special problems, then the cost becomes relatively unimportant. However, if one looks upon separated isotopes as a new tool for chemical research in all its various aspects, then the matter of production cost on a commercial basis is important. The value of such stable isotopes as tracers, as compared with the value of radioactive isotopes, depends upon the amount by which the material can be diluted before the tracer can no longer be detected, upon the size of sample that is required for analysis, and upon the convenience of the analytical method. It is very difficult for me to speak authoritatively in regard to other methods of separation than these chemical ones, but in the case of the chemical method it is of interest to record some facts in regard to the cost, and the usefulness of the separated isotopes particularly for tracer use.

The rate of production by chemical methods, using apparatus of the type I have described, is considerably larger than that of any other type of separation that has been used, so far as I am aware. In the case of our nitrogen experiments, it was possible to transport 0.75

gram of N^{15} per 24-hour period, while on the carbon experiment (using only the two smaller units) we have been able to transport 0.15 gram of C^{13} per 24-hour period. There seems to be no reason why these methods can not be increased almost indefinitely on a commercial scale. It should be possible to increase the production by at least a factor of 10 on the basis of present knowledge in both cases. The cost of production depends greatly upon the scale on which one works. In our experiments on nitrogen, using the laboratory size apparatus, we were able to produce N^{15} for a cost of about $50 per gram of N^{15}, including the cost of chemicals and the salaries of the men operating the apparatus. There seems to be no reason why this cost can not be lowered to something in the neighborhood of $15 per gram of N^{15}, or less. In the case of carbon, our cost for salaries and chemicals amounts to about $200 per gram, although there appears to be no reason why this cost can not also be brought to the neighborhood of $15 or $20 per gram if the production is maintained on a sufficiently large scale.

These figures, of course, can not be regarded as total costs for the reason that in any commercial venture it is necessary to charge overhead, which is an important part of the cost of production, but it does seem probable that these isotopes can be produced and sold for something in the neighborhood of $50 per gram.

The dilution factor of the material we are now producing, 25 percent C^{13}, is approximately 2500 to 1, if we assume that the precision of a mass spectrometer is limited to 1 percent of the natural abundance of C^{13}. If mass spectrometers can be devised which are able to detect 0.1 percent of the natural abundance of C^{13}, and this does not seem impossible, the dilution factor for our present material is 25,000.

The sample required for satisfactory analysis with a mass spectrometer is in the neighborhood of 1 cc of gas at atmospheric pressure, and if necessary this could quite easily be reduced to one-fifth of this, or approximately 0.1 milligram of C^{13}. The method of analysis requires a rather extensive and somewhat expensive piece of apparatus, and one that at the present time is often difficult to keep in satisfactory adjustment. There appears to be no reason, however, why such an apparatus can not be made commercially in a much more convenient form than those now in use in our laboratories, and at a cost comparable to medium sized spectrographs.

Distillation, chemical exchange reactions, thermal diffusion, and centrifugal evaporation all depend upon the possibility of using volatile compounds. The relative advantages of the thermal diffusion and the chemical methods can be rather well evaluated at the present time. The chemical methods rapidly become ineffective as atomic weights increase. For example, it would appear that fractionation factors in the neighborhood of 1.0002 might be expected in the case of elements of atomic weight 200 or more, instead of 1.02 as in the case of carbon and nitrogen. It is thus evident that it will probably be impossible to effect any separation of isotopes on an effective scale by chemical methods for elements above 40 in atomic weight. On the other hand, the thermal diffusion coefficient can be expected to be about 0.1 as great for elements of atomic weight 200 or more, as for carbon. Thus we see that its use over a wider range of the periodic system is possible, although the speed of the method per unit apparatus is only about 5 or 10 milligrams of C^{13} per 24-hour period. To attain a production of 1 gram of C^{13} per 24 hours would require at least 100 thermal diffusion tubes, while the chemical separation can be effected on the same scale with a single apparatus of somewhat more extensive character than those already used. While the thermal diffusion method can be easily operated without attention, chemical methods require constant attendance. The comparison for a case such as carbon comes to a matter of cost of production. Electrical current is particularly expensive for the thermal diffusion method, probably running in the neighborhood of $100 per gram of C^{13} transported. Other methods of heating can hardly be expected to have the uniformity and the steady character required for the efficient operation of the process. It seems quite certain that the construction and operation of 100 thermal diffusion tubes can not be expected to be as economical as the operation of a single chemical separation apparatus, even though the chemical method must have constant attention. Moreover, if larger amounts are needed the chemical method can be extended to larger scale apparatus by methods that are well understood in the chemical industry.

Turning to the possible separation of the elements of high atomic weight, we see that the centrifugal fractionation column is the most feasible method. It should have a transport per unit comparable to chemical exchange units of approximately the same size. Moreover, the effectiveness of separation should decrease very slowly with increased atomic weight, the decrease being due to slower rates of diffusion in the case of high atomic weight substances, and not due to a decrease in the effective fractionation factor.

It is always interesting to speculate on where the next important development of a subject will take place. At the present time the separation of the uranium isotopes would probably lead to most interesting progress in the study of the fission process of the uranium isotope of mass 235. Thermal diffusion seems to be a possible method for accomplishing this, although no very great speed can be expected. It would seem to me that the centrifugal fractionation column or some modification of this would be a most likely method for securing results on this most fascinating problem, and in my opinion this is the most important direction for research on the concentration of isotopes at the present time.

I have been greatly aided in the work that I have reported in this lecture by my colleagues who have worked with me for various periods of time since this work was started about five years ago. Prof. John R. Huffman, now at New York University, aided with the distillation experiments on the O^{16} and O^{18} waters and with the early experiments on the separation of the nitrogen isotopes. Prof. Harry G. Thode, now at McMasters University, did much of the work on the final separation of the nitrogen isotopes and aided with the first experiments on C^{13}. Prof. Clyde A. Hutchinson, now at the University of Buffalo, Dr. Irving Roberts, of Weiss & Downs, Inc., and Dr. David W. Stewart, of Columbia University, are in a large measure responsible for the success of the separation of carbon. Dr. Karl Cohen has helped with the more recent experiments and has carried through the calculations on the fractionation process reported in this paper. From time to time other men have aided us with the actual mechanical work of carrying on these rather arduous experiments. My thanks and appreciation are due to all these men, for the program could not have been performed without the loyal help of my co-workers.

BOTANY.—*Aublet the botanist, a pioneer against slavery, with a memorial genus of palms.*[1] O. F. Cook, Lanham, Md.

Darwin's reaction against slavery, during his visit to Brazil in 1832, has figured as an example of humanitarian sentiments combined with scientific pursuits, to show that science is not so aloof from human interests as often supposed. Cuvier affirmed "the power of feeling to exalt the intelligence," but curiosity affects the mysterious and remote. Darwin noted in Galton's questionnaire on heredity that more originality is implied in "discoveries with regard to common objects," and Aublet saw significance in simple racial reactions that continued to be disregarded through the slavery controversy. From a scientific standpoint it must be expected that the racial and social problems,

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[1] Received December 22, 1939

since they lie in the field of biology, eventually will be studied by consecutive scientific methods, and that each discovery or original approach to a significant fact will be recognized, appreciated, and commemorated.

Aublet not only was much earlier than Darwin but was well in advance of most of the philanthropists who gained distinction through their efforts for the suppression of the slave trade and the abolition of slavery, as Sharp, Wilberforce, Buxton, Garrison, and Phillips. Abbé Gregoire did not organize his "Friends of the Blacks" till 1788, the same year when Brissot de Warville traveled in the United States with a zealous interest in the "wretched Africans." Clarkson's survey of his "forerunners," in *The history of the abolition of the slave trade*, 1808, does not refer to Aublet, nor does Saco's *Historia de la esclavitud*, 1879–1903.

Jean Baptiste Christophe Fusee Aublet, a contemporary of the Jussieus, was born in Provence in 1720, and is chiefly known for his *Histoire des plantes de la Guiane Françoise*, 1775, in four octavo volumes, the foundation of forest botany in tropical America. Nearly 400 new plants were described and figured, including many new genera of trees. Piso, Plumier, Browne, Sloane, and Jacquin had explored the plant world of the West Indies and the shores of South America, but Aublet entered the continental forest and began the study of its seemingly inexhaustible flora, continued by Ruiz and Pavon, Martius, Spruce, Pittier, and many others. Aublet was bent on botany even as a boy, ran away to Spain in search of plants, and worked a year for an apothecary at Granada before he was traced and taken home.

The Guiana collection was made in two years, 1762–1764, but Aublet had spent 9 years, 1753–1761, in establishing a garden of drug plants in Mauritius, then a French colony, "l'Isle-de-France." In returning from Guiana he spent several months in "Saint-Domingue," at Mole Saint Nichols, Bombardopolis, and other points in the northern peninsula of Haiti. Thus Aublet had active experience in three of the tropical colonies as a basis of his chapter on "Observations sur les Negres Esclaves," published in the supplement of the *Histoire*.

Slavery had been challenged on grounds of religious sensibility from the time of Las Casas in the sixteenth century, more frequently after George Fox visited Barbados in 1671 and urged a gradual emancipation of the slaves, as did John Woolman in Maryland and Virginia before the Revolutionary War. Aublet was a secular voice, perhaps the first to be raised, objecting to the system of slavery as injurious to the European settlers. He saw that the French colonists, from being kindly, good-natured people, became haughty, hard, and inhuman in dealing with another race, but saw no object in this severity, the Negroes being, in his view, not turbulent savages, but naturally quiet, peaceable people, not entirely irresponsible or unwilling to work for what they might need.

Thus Aublet reached the conclusion that holding the Negroes in slavery was not necessary for maintaining the colonies, a racial judgment that received a practical demonstration in hundreds of separate communities on tropical coasts and islands when the system of forced labor eventually was abandoned. Much of the calamitous history of Haiti and of the United States might have been avoided if Aublet's factual view of the Negro character had prevailed before the explosive tensions were generated. It generally was believed that continuous repression was required and that the Negroes would revolt at the first opportunity. John Brown had that idea, and many other abolitionists.

In the light of subsequent history it will not be questioned that the effect of slavery on the ruling class was a serious factor of the racial problem of the West Indies. From Bolingbroke's *Voyage to the Demerary*, 1807, it appears that many of the islands were going backward long before the slaves were liberated. Emancipation did not change the essential conditions, and the decline continued. "A ruling class always rules itself out." Some of the finest islands have been entirely abandoned to the Negroes, and now this "New Africa" is reported in serious distress. Macmillan's *Warning from the West Indies*, 1936, urges an extension of the policy of trusteeship, "development in the interest of the weaker classes," as projected for the African colonies. The notion of ruling another race takes another form, benevolent, of course, but requiring "a firm exercise of authority in their behalf." In South Africa it is being recognized that the exploitive relations are detrimental to both races, and measures of segregation are being applied.

A few years after Aublet an English botanist, Henry Smeathman, outlined a plan for settling colonies of civilized Negroes on the coast of Africa, in order to end the slave trade and eventually to return the slave population from America. Smeathman went to Sierra Leone in 1771 to collect plants for a scientific group of English Quakers described by R. Hingston Fox in *Dr. John Fothergill and his friends*, 1919. An African tree of the passion-flower family was named *Smeathmania* by Robert Brown, in Tuckey's Congo *Narrative*, 1818. Two of Smeathman's letters, dated 1783 and 1786, relating to a proposed settlement at Sierra Leone were included in Wadstrom's *Essay on colonization*, 1794. Smeathman's account of the social economy of the African termites, published by the Royal Society in 1781, is praised in Maeterlinck's *Life of the white ant* as an "inexhaustible treasure" of basic observations.

The policy of colonization had the approval of Washington and Jefferson, and settlements in Liberia were developed by Ashmun (1822–1828) to the point of showing that the project was feasible, though later mismanaged and discredited, but still finding a few supporters in each generation. Senator Bilbo of Mississippi recently has proposed in Congress a "Greater Liberia Act," for resuming and extending "the voluntary resettlement of American Negroes in Africa." A century of peaceable history in Liberia confirms Aublet's assay of the racial temperament.

A GUIANA PALM GENUS TO COMMEMORATE AUBLET

The palm called "maripa" in French Guiana, figured on the frontispiece of Aublet's *Histoire* and described in the Supplement, is distinct as a genus from the South American palms with which it has been associated and may receive the name **Ethnora**, to symbolize the interest of Aublet in the racial problems The name *Attalea maripa* was given to Aublet's palm by Martius, and Drude called it *Maximiliana maripa*. The type species would appear as *Ethnora maripa* (Martius). The ample duplex perianth, uniform, crassate endocarp, and superficial submedial foramina, are diagnostic characters. The pulp of the fruit yields an edible oil. The related genera were reviewed in the National Horticultural Magazine for October 1939, in a paper entitled "*Bornoa*, an Endemic Palm of Haiti."

Other distinctive features of *Ethnora* are the low, robust trunk, rather short leaves, and the pedunculate inflorescence, less compact than in *Bornoa*. The large orbicular-apiculate petals are half as long as the fruit, twice as long as the broadly cordate-auriculate sepals, and about three times as long as the tomentose laciniate staminal cup. The stigma is persistent, the rostrum indurated, the exocarp firm, the mesocarp fleshy and fibrous with a compact inner layer of longitudinal mesocarp fibers adhering closely to the endocarp but not fused, the cross section showing only the few fibers that outline the sutural sclerites. One or two carpels are fertile, the endosperm narrowly striate on the outer face, and the slender curved embryo protected by a papilliform process of the indurated testa. Fruits from Dutch Guiana collected by Harold F. Loomis for the Allison V. Armour Expedition of 1932 have been examined.

The endocarp of *Ethnora* is remarkable, the walls very thick and extremely hard, of uniform texture, with no peripheral fibers, but the sutural sclerites distinctly outlined in the cross section of the nut by parallel series of fibers, rather regularly spaced. In *Bornoa* the sutural bands appear as segments of the outer wall separated by a few fibers in radial or oblique rows, but in *Ethnora* it is plain that the bands project as radial flanges from the center of the nut and are structurally distinct from the thickened walls of the carpels, which doubtless must be considered as the endocarp proper. The central structure is hardly to be viewed as a receptacle or a placenta but

Fig 1.—Aublet's maripa palm.

may represent an intermediate metamere, between the stamens and the pistils. The nut of *Temenia* (*Maximiliana*) shows the same structure as *Ethnora*, but the walls are much thinner, with the pits that mark the sutural bands more numerous, closer to the surface of the chambers, and distinctly flattened.

The personal name *Aubletia* is not available, Gaertner in 1788 and four other botanists within a few years having dedicated new genera to Aublet. Only the first genus could be recognised, and that proved invalid.

A reduced photograph of Aublet's frontispiece is reproduced (Fig. 1), with an enlargement of the details of the maripa palm. The four other palms "comon," "avoira," "bache," and "zaguenete" are identified respectively as *Oenocarpus*, *Astrocaryum*, *Mauritia*, and *Manicaria*. No other palms were illustrated in Aublet's *Histoire*, though several were briefly described, without botanical names. The leaf above the medallion may represent the "comon."

The palm of Dutch Guiana may be a different species, since it develops a tall, clean, cylindrical trunk. A single fruit of this palm is 7 cm by nearly 4 cm, the petals attaining 4 cm and the sepals 2 cm. An inflorescence branch with 6 fruits is 18 cm long, the basal joint nearly 4 cm the other joints about 2 cm, and the slender male section 4 cm.

The name "cocorite" or "kokerite" also is applied to palms of this group in Guiana and Trinidad, usually classified under *Maximiliana.*

In British Guiana, according to Im Thurn, the cocorite palms are short or even stemless in the coast districts, but in the interior grow very tall, "the grandest column-like stem that palm ever had." The name "mareepa" is given by Im Thurn as relating to the seeds of the cocorite palm.

From Aublet's descriptions a genus *Avoira,* with six formally named species, was recognized by Giseke in 1792, though generally overlooked in taxonomic literature Giseke's genus antedates *Astrocaryum* Mayer, 1818, but may prove distinct. The type species, *Avoira vulgaris*, is represented in Aublet's drawing by a branch of the inflorescence with several fruits, while a branch of *Astrocaryum aculeatum* Mayer appears from the original description to have only one female flower, at the base of a slender "stipe" equal in length to the thickened male spike.

BOTANY.—*A second note on Georgia Discomycetes.*[1] EDITH K. CASH, U. S. Bureau of Plant Industry. (Communicated by JOHN A. STEVENSON.)

During the past few years the writer has had the privilege of studying numerous specimens of Discomycetes collected in the vicinity of Athens, Ga., by J. H. Miller and G. E. Thompson, of the University of Georgia. Several of these fungi have been discussed previously (2); notes are given here on five additional species, four of which are described as new. Specimens are in the herbarium of the University of Georgia and in the Mycological Collections of the U. S. Bureau of Plant Industry, and type material has also been deposited in the Farlow Herbarium of Harvard University and the herbaria of the New York Botanical Garden and the University of Michigan.

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[1] Received January 2, 1940.

Sphaeropezia arundinariae, n. sp. Fig. 1

Apothecia irregularly scattered over the stems of the host plant, ellipsoid or elongate, 0.7–1 by 0.3–0.5 mm, deeply embedded in the tissue, at first completely covered by a lid concrete with the darkened and convexly arched epidermis, which later splits longitudinally to expose the sunken hymenium; hymenium pale flesh color to vinaceous-buff (Ridgway),[2] pruinose; asci cylindrical, rather abruptly narrowed to the apical pore, gradually attenuated toward the base, pore blue with iodine, 8-spored, 75–85 by 6–8μ; spores irregularly biseriate, hyaline, cylindrical-clavate, 3-septate, not constricted, rounded at the ends and narrowed at the lower end, 16–18 by 3–4μ; paraphyses hyaline, filiform, simple or branched near the tips, often twisted or circinate; hypothecium hyaline or subhyaline, of small-celled plectenchyma; exciple prosenchymatous, brown, enclosing the hymenial layer at the base and sides and the cover above it in a continuous layer; cover concrete with the epidermis, the outer layer prosenchymatous, brown, with a thick inner layer of hyaline, gelatinous longitudinal cells, opening by a lengthwise slit, the sections extending perpendicularly or more frequently breaking away at maturity and leaving only a few fragments around the margin of the hymenium.

Apotheciis conspersis, ellipsoideis vel elongatis, 0.7–1$\times$0.3–0.5 mm, immersis, clypeo epidermide adnato et longitudinaliter fisso et hymenium pallide-roseum pulverulentum patefacienti; ascis cylindricis, octosporis, 75–85 $\times$6–8μ; ascosporis biseriatis, hyalinis, cylindrico-clavatis, 3-septatis, base attenuatis, 16–18$\times$3–4μ; paraphysibus hyalinis, filiformibus, simplicibus vel apice ramosis, saepe circinatis, hypothecio subhyalino, plectenchymatico; excipulo prosenchymatico, brunneo.

On the small branches of *Arundinaria tecta*, Bobbin Mill, Athens, Ga., April 27, 1938, J. H. Miller, and April 5, 1939, G. E. Thompson and J. H. Miller (*type*).

This fungus was at first tentatively placed in the genus *Phragmonaevia*, which it resembles in its sunken apothecia and hyaline, septate spores. The inadequate descriptions of many species of this genus make their real characters and affinities questionable. Details of the structure and development, particularly the manner of opening and the nature of the covering layer, if present, are usually not noted. Although von Hoehnel in several instances (4, 5, 6) notes the resemblance of some species of *Naevia* to *Phacidium*, at one time classifying the genus *Naevia* in the Phacidiaceae, he consistently regarded *Phragmonaevia* as belonging to the Stictidaceae, as have Saccardo and Rehm, among other writers. The fungus on *Arundinaria*, however, can not be considered as stictidaceous, being plainly most closely allied to the Phacidiaceae. The structure of the apothecium is strikingly similar to that of *Phacidium lacerum* Fr., the type of the genus *Phacidium*, as illustrated and described by von Hoehnel (4, p. 317, fig. 15). Von Hoehnel's figure shows a similar covering lid, open and extending vertically at right angles to the hymenium, with an inner layer of mucilaginous cells, which he interprets as an opening mechanism.

[2] Color terminology follows Ridgway, *Color standards and color nomenclature*, Washington, D. C., 1912.

Several species of *Phragmonaevia* growing on grasses are transferred by von Hoehnel and Nannfeldt to *Hysteropezizella* v. Hoehn., a genus characterized by elongate ascomata, a covering lid concrete with the epidermis and opening at one side, simple spores, and acute lanceolate paraphyses. *S. arundinariae* differs from *Hysteropezizella* in the filiform, flexuous paraphyses, septate spores, and most especially in the prosenchymatous exciple. No pseudoparenchymatous basal tissue, such as that illustrated and described by von Hoehnel and Nannfeldt, could be found in this fungus.

The original description of *Sphaeropezia* Sacc. (10, p. 253) is brief, and the type species, *S. alpina* Sacc., appears not to have been available for study by later workers, so that the position of the genus is not clear. First described as a genus of the Patellariaceae by Saccardo, it was referred by Rehm (9, p. 72–73) to the Phacidiaceae, a classification that was adopted by Saccardo in the *Sylloge Fungorum*, volumes 8–24, and followed by von Hoehnel (5). Nannfeldt (8, p. 214), on the other hand, on the basis of his examination of *S. empetri* (Fckl.) Rehm, considers *Sphaeropezia* a member of the Pseudosphaeriales, removing it from the Discomycetes completely, but not assigning it definitely to any family. In the absence of more adequate information, the writer has followed the usage of Rehm and von Hoehnel in describing this fungus as a *Sphaeropezia*.

Lachnum arundinariae, n. sp. Fig. 2

Apothecia sessile, scattered, amphigenous, mostly hypophyllous, superficial, minute, 0.1–0.2 mm in diameter, translucent when moist, white-pilose, subglobose then patellate, soft-fleshy, hymenium hyaline to sea-shell pink (R), margin fimbriate; asci cylindrical, short-pedicellate, rounded at the apex, 8-spored, 27–33 by 3–3.5μ; spores narrow-clavate to acicular, biseriate, unicellular, hyaline, straight, 5–6.5 by 0.7–1μ; paraphyses lanceolate, 45–55 by 3–4μ; exciple hyaline, prosenchymatous; hairs hyaline, septate, finely echinulate, not swollen at the apex, 50–70 by 3μ.

Apotheciis sessilibus, amphigenis, 0.1–0.2 mm, molle carnosis, albo-pilosis, margine fimbriato, hymenio carneo, ascis cylindricis, breve pedicellatis, octosporis, 27–33×3–3.5μ; ascosporis anguste clavatis vel acicularibus, unicellularibus, hyalinis, 5–6.5×0.7–1μ; paraphysibus lanceolatis, 45–55×3–4μ; excipulo hyalino, prosenchymatico; pilis hyalinis, septatis, echinulatis, 50–70×3μ.

On *Arundinaria tecta*, Bobbin Mill, Athens, Ga., April 27, 1938, J. H. Miller, and May 12, 1939, G. E. Thompson and J. H. Miller (*type*).

Judged from the description, *Peziza caulicola* Fr. (3, p. 94), reported on *Arundinaria*, is close to *Phialea cyathoidea*. Both the former species and *Peziza arundinariae* Berk. (1, p. 155) differ from *Lachnum arundinariae* in color and in the presence of a stipe. Among species of *Lachnum* that occur on grasses, *L. carneolum* (Sacc.) Rehm f. *hyalinum* (Rehm, Ascomyceten no. 1931) is more densely pilose, with thicker, longer, crystal-bearing hairs, larger asci and spores, and shorter paraphyses; *L. nardi* Rehm is a darker, stipitate species; and European specimens of *L. controversum* (Cke.) Rehm show larger, stouter apothecia, with clavate-tipped hairs and spores equally acute at both ends.

Pyrenopeziza minuta, n. sp. Fig. 3

Apothecia hypophyllous, subcuticular, becoming superficial with the disorganization of the host tissue, closely aggregated in pale spots of withering leaves, patellate, pale brown when moist with subhyaline hymenium, entire fungus black when dry, very inconspicuous, 150–175μ in diameter, soft fleshy to membranous, margin uneven; asci clavate to fusoid, rather abruptly narrowed at the apex and base, 8-spored, 28–33 by 4–5μ; spores biseriate or irregularly 3-seriate in the upper part of the ascus, acicular clavate, 4–5 by 0.7–1μ; paraphyses filiform, hyaline, swollen at the tips to 2–3μ in diameter and conglutinate in a yellowish mazaedium; hypothecium thin, subhyaline, outer layer dark at the base, of elongate, yellow-brown hyphae forming a dentate margin.

Apotheciis in maculis hypophyllis, subcuticularibus dein superficialibus, patellatis, pallide brunneis, 150–175μ diam., molle-carnosis vel membranosis; ascis clavati-fusoideis, octosporis, 28–33×4–5μ; ascosporis 2-3-seriatis, aciculari-clavatis, 4–5×0.7–1.2μ; paraphysibus filiformibus, hyalinis, apice inflatis et conglutinatis; hypothecio tenui, subhyalino; excipulo brunneo.

In withered leaves of *Tilia heterophylla* var. *michauxii*, Princeton, Ga., April 26, 1938, and March 25, 1939 (*type*), J. H. Miller and G. E. Thompson.

This species differs from *Naevia tiliae* (Kleb.) Nannf. (8, p. 190) in smaller asci and spores, longer paraphyses, and in the thinner, darker basal tissue.

Pyrenopeziza prinicola (E. & E.), comb. n.

Synonym.—Mollisia prinicola E. & E., Journ. Myc. 4: 99. 1888.

Apothecia erumpent, then superficial, scattered rather thickly and evenly over the lower surface of the leaf, minute, 150–275μ in diameter, subturbinate then patellate, membranous to fleshy, hymenium alutaceous to dark brown, the entire fungus black when dry, margin slightly crenulate; asci clavate, abruptly narrowed at the base and apex, 8-spored, 33–40 by 6–8μ; spores irregularly 2–3-seriate, hyaline, acicular-clavate, 1-celled, guttulate, becoming pseudoseptate near the middle, the lower end acute and narrowed, straight, 10–15 by 1–1.5μ; paraphyses filiform, hyaline, simple or branched near the tips, hypothecial layer hyaline, plectenchymatic, 15–20μ thick, gradually changing to subhyaline pseudoparenchyma at the base; exciple subhyaline at the base, dark toward the margin, covered with brown hyphae 2–3μ in diameter adnate with remnants of the host cuticle.

On dead leaves on *Quercus stellata*, Bobbin Mill, Athens, Ga., April 27, 1938, J. H. Miller; on *Quercus rubra*, same locality, May 12, 1939, G. E. Thompson and J. H. Miller. Type on *Q. prinus*, Louisiana, 1888, A. B. Langlois 1329.

Comparison with the type specimen of *Mollisia prinicola* E. & E. in the Mycological Collections of the Bureau of Plant Industry shows that the Georgia material constitutes recent collections of the same species, which is, however, more properly a *Pyrenopeziza* than a *Mollisia*.

So far as can be ascertained from descriptions and available specimens this American fungus is not identical with similar European species occurring on oak leaves. *Mollisia rabenhorstii* (Auersw.) Rehm (9, p. 537) has smaller asci and spores, apothecia free from the host tissue at the border instead of adnate with it, and a darker, large-celled pseudoparenchymatous exciple with conspicuous, broad, clavate ends of hyphae projecting at the margin. Rabh. F. Eur. 2312, issued as *Pyrenopeziza foliicola* Fckl. and cited by Rehm as *M. rabenhorstii*, agrees with Rehm's description of the latter species; Sacc. Myc. Ven. 975, labeled *Pyrenopeziza foliicola* (Karst.) Sacc. f. *quercus pedunculata*, and *Peziza nervicola* Desm. in Desm. Pl. Crypt. Fr. 1067 also appear to be the same fungus, differing from *P. prinicola* in the characters mentioned.

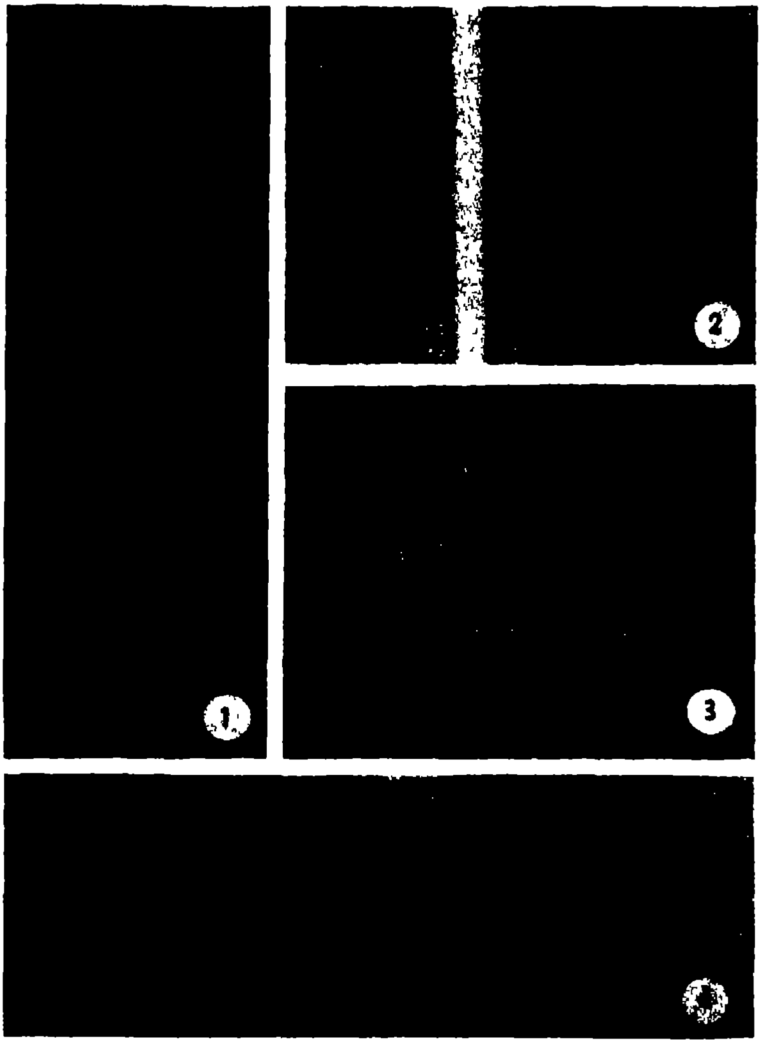

Fig. 1.—*Sphaeropezia arundinariae* on *Arundinaria tecta* (× 5). Fig. 2.—*Lachnum arundinariae* on *Arundinaria tecta* (× 20). Fig. 3.—*Pyrenopeziza tiliae* on *Tilia heterophylla* var. *michauxii* (× 18). Fig. 4.—*Phaeangium magnisporum* on *Betula nigra* (× 5). Photographs by M. L. F. Foubert.

Phaeangium magnisporum, n. sp. Fig. 4

Apothecia erumpent singly or in groups of two to three, closely surrounded by fragments of broken bark, 1–1.5 mm in diameter, fleshy, subturbinate or obconic, smooth, black, often compressed and contorted, readily falling out, leaving cavities in the bark, hymenium fuscous-black (R), shining, rough; asci broad-cylindrical, abruptly narrowed at the base, rounded at the apex, 4-spored, 175–200 by 25–30μ; spores uniseriate, broad-ellipsoid, dark brown, 1-celled, with one large guttule evident when young, smooth, surrounded by a thick hyaline gelatinous envelope 2–2.5μ thick, 40–50 by 19–22μ (exclusive of enveloping sheath); paraphyses numerous, filiform, with granular contents, branched and interwoven at the tips, forming a subgelatinous mazaedium; hypothecium subhyaline, of very loosely formed plectenchyma, becoming darker and more closely interwoven toward the base; outer layer of cells breaking up irregularly and forming a furfuraceous cortex.

Apotheciis erumpentibus, carnosis, subturbinatis vel obconicis, 1–1.5 mm diam , nigris, hymenio fusco, nitenti, rugoso, ascis late-cylindricis, 4-sporis, 175–220×25–30μ; ascosporis uniseriatis, late-ellipsoideis, nigro-brunneis, unicellularibus, 40–50×18–22μ, tunica gelatinosa, 2–2.5μ crassa involutis; paraphysibus numerosis, filiformibus, apice ramosis et intertextis, mazaedium gelatinosum formantibus; hypothecio subhyalino, plectenchymatico, cortice furfuraceo.

In bark of *Betula nigra*, Agr. Campus, Athens, Ga , March 2, 1939, G. E. Thompson and J. H. Miller

P. magnisporum is related to *P. tetrasporum* (Ell) Sacc. & Syd , described by Ellis on *Quercus coccinea* from New Jersey as *Dermatea tetraspora* In the specimen of the latter species examined (Ellis, N Am Fungi no. 70), the spores are subspherical, 22–28.5×18–20μ, none reaching even the minimum length of those in *P. magnisporum* *P. peckianum* Sacc (11, p. 190) on *Acer* differs in more caespitose apothecia and much smaller asci and spores.

Nannfeldt has pointed out (7, p. 202) (8, p. 92) that several fungi described as *Phaeangium* are in reality species of *Dermatea, Pezicula,* and *Velutaria,* the brownish spore coloring being apparently due to age and poor condition of the specimens This does not seem to be the case, however, in *P. tetrasporum* and *P. magnisporum,* in which the spores are brown in a very early stage, becoming when mature an intense dark brown, similar to the color of *Xylaria* spores. The name *Phaeangium* is therefore retained for the present for these two species, in order to avoid the necessity of naming a new genus.

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ENTOMOLOGY.—*Ten new West Indian scarab beetles of the genus* Phyllophaga, *with two new names.*[1]

Lawrence W. Saylor, U. S. Bureau of Biological Survey. (Communicated by E. A. Chapin.)

The species described as new in this paper further enlarge our knowledge of the relatively numerous species of June beetles known from the West Indies. For the privilege of studying the majority of these new species I am indebted to Dr. E. A. Chapin, of the United States National Museum.

Phyllophaga (Phyllophaga) bimammifrons, n. sp. Fig. 2

Male.—Elongate, shining, glabrous above, head piceous, thorax and legs rufotestaceous, otherwise testaceous above Clypeus with moderately fine punctures, these dense at center of disk but nearly absent along apical margin of clypeus, clypeal margin slightly reflexed, narrowly and shallowly incised at middle, the angles very broadly rounded; underside of outer apical margin with a single row of punctures, each bearing a long hair, which curves up and back over the clypeal apex Front with two moderately separated mammilliform tubercles; apical half of disk of the front with fine, sparse, and irregularly placed punctures, basal half of disk and vertex with very dense and extremely fine punctures and several larger intercalated punctures. Antenna 9-segmented, club not quite equal in length to the four preceding segments Thorax with sides entire, with a few cilia near the apical angles, both hind and fore angles rounded, base and apex with strong, complete margins, punctures of disk of moderate size, rather regularly placed and separated by one to two times their diameters, the center of disk with a small irregular, impunctate area. Elytron with sutural stria obsolete at base and apex, other striae absent, disk subrugose, punctures slightly smaller than those of thorax and less densely placed. Pygidium convex, subrugose, with fine, regularly placed punctures, separated by about two times their diameters and each bearing a short, erect hair. Abdomen convex, polished, fifth sternite sparsely punctured; sixth sternite three-fifths as wide as the preceding, slightly transversely impressed and with fine, moderately dense, setigerous punctures. Claws with a strong median tooth, claw base obtusely dilated.

Female—Antennal club equal to the three preceding segments; pygidial puncturation somewhat coarser than in male, and disk somewhat tumid before apex; abdomen with the sixth sternite flat. Otherwise as in the male.

Length, 21–23 mm Width, 11–12 mm

The type series consists of 12 males and 8 females, 10 from "Sta. Fe, I. de Pines, Cuba, A. R. Otero collector, March 1939 (E.E.A. Cuba Ento. No.

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[1] Received February 9, 1940.

11013)" and 10 from the same locality collected March 21, 1939. The *holotype* (U.S.N.M. no. 54014), *allotype*, and designated paratypes are in the United States National Museum; paratypes also have been returned to S. C. Bruner, who kindly sent the series for study, and others have been deposited in the Saylor Collection.

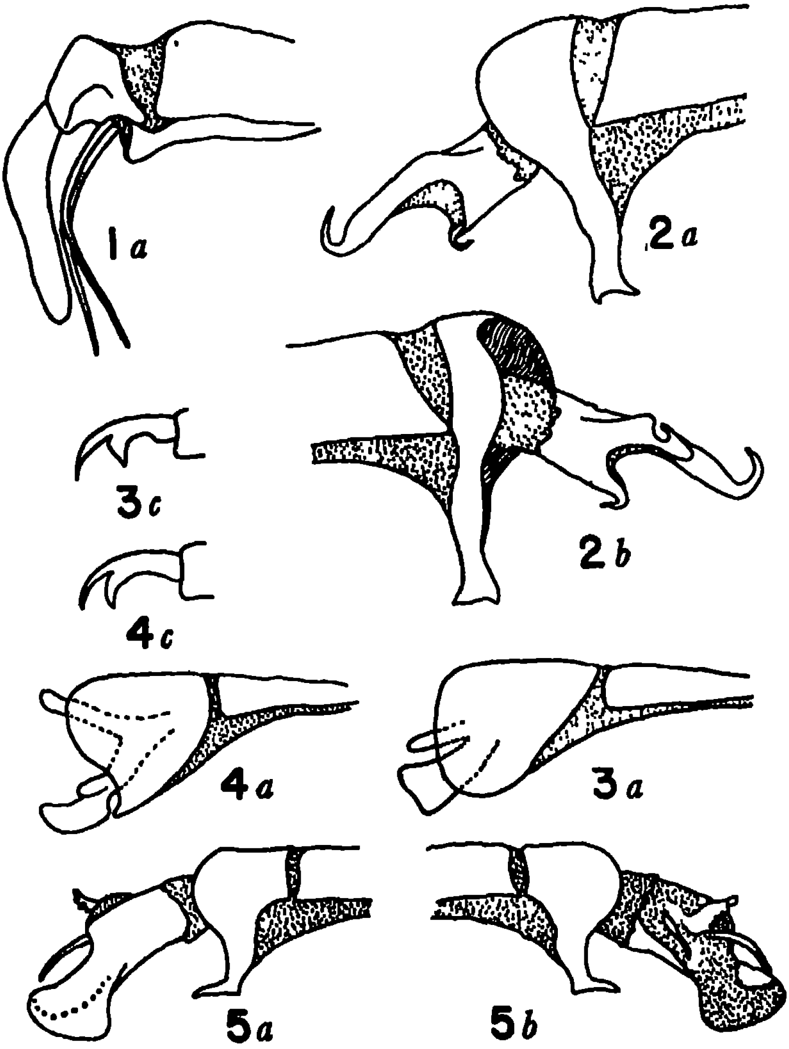

Fig. 1.—*Phyllophaga adjuntas*, n. sp. Fig. 2.—*Phyllophaga bimammifrons*, n. sp. Fig. 3.—*Phyllophaga cneda*, n. sp. Fig. 4.—*Phyllophaga blackwelderi*, n. sp. Fig. 5.—*Phyllophaga bahama*, n. sp. *a*, and *b*, Lateral view of male genitalia. *c*, Tarsal claw.

P. bimammifrons is most closely related to *P. tuberculifrons* (Chev.), with which species it has in common the bimammillate front, but it may be readily separated by the more median tooth of the tarsal claw and the very different male genitalia. In this new species only the females have the smooth reniform impression adjacent to each eye that Chapin describes for *tuberculifrons;* in the males the area is punctate to the eye margin.

Phyllophaga (Phyllophaga) wolcotti, n sp Fig 10

Male.—Elongate, testacco-ochreous to testaceopiceous, head and greater part of the thoracic disk piceous, legs rufopiceous; upper surface pruinose, dull, glabrous. Head with clypeus polished, very sparsely punctate, apex narrowly and shallowly emarginate, angles very broadly rounded. Front pruinose, with sparse, small, irregularly placed, umbilicate punctures, vertex and occiput polished and impunctate Antenna 9-segmented, club oval, equal to or slightly longer than the preceding three segments. Thorax with small, irregularly placed, umbilicate punctures, separated by one to two or more times their diameters; lateral margins entire, angles well marked but obtuse, base entirely margined Elytron with sutural stria obsolete basally and apically; disk subrugose, with punctures of same size and density as those of the thorax Pygidium convex, polished, glabrous, with small, moderately dense umbilicate punctures. Abdomen slightly convex, with very fine punctures, glabrous or nearly so at middle, fifth sternite long and with sparse transverse punctures; sixth sternite one-third the length of the preceding, with a deep transverse sulcus, surface hardly punctate Claws with a strong median tooth, which is long and as strong as the apical one; claw base angularly dilated. Metasternal hairs of moderate thickness Propygidium strongly polished but with several very minute punctures visible.

Female—All characters as in the male except that the sixth ventral abdominal sternite is much less strongly impressed and the antennal club is a little shorter.

Length, 23–24 5 mm Width, 11 12 5 mm.

The *holotype* (U.S.N.M no 54015), *allotype*, and 2 paratypes are from "El Yunque, Porto Rico," collected by G N Wolcott on April 6, 1939. An additional pair of paratypes are from "Mts N of Yauco, P Rico, IV-20-36, coll by R. G. Oakley " The holotype, allotype, and a paratype are in the United States National Museum, a pair of paratypes is in the collection of Wolcott, and one paratype has been deposited in the Saylor Collection.

The species is named in honor of G. N. Wolcott, who has contributed much to our knowledge of Puerto Rican melolonthids and who transmitted part of the specimens for description *P. wolcotti* is most closely related to *P yunqueana* Chapin, but besides the quite different male genitalia, it may be separated by the darker color, less densely punctate head, nontumid clypeus, and shorter antennal club

Phyllophaga (Phyllophaga) spinifemora, n. sp. Fig. 6

Male—Oblong oval, shining, glabrous above; pale testaceous, the head and legs varying to rufotestaceous Clypeus short, densely punctured, apex widely and moderately deeply emarginate, almost bilobed, angles well rounded, margin hardly reflexed. Front with very dense punctures of moderate size, with or without an indication of a slightly impressed, longitudinal sulcus; vertex polished, impunctate Eyes rather large. Antenna testaceous, apparently 8-segmented, the fourth segment as long as the second and third combined and widened at the middle, fifth segment one-third as long as the preceding; club equal to funicle in length. Thorax with regularly placed punctures of moderate size, separated by one and one-half to two times their diameters, somewhat closer along the front margin and near sides; sides rounded, angles blunt, lateral margins entire, with very short cilia; hind marginal line absent. Elytron with sutural stria ill-defined, hardly raised, and punctate; disk subrugose, with moderately dense punctures Pygidium convex, polished, either glabrous or with a few short and erect hairs, and with regularly placed moderate to rather large punctures, the punctures separated by one to two times their diameters. Abdomen polished, slightly convex; fifth sternite slightly transversely impressed, the apical margin at middle prolonged into a slight though evident lobe; sixth sternite one-third as long as fifth, transversely impressed and punctate Claws short, with a stuby triangular tooth at the middle. Upper tooth of front tibia well defined. First two segments of hind tarsus equal in length. Hind femur with a single row of 6 to 10 backwardly projecting, short stubby spines well inside of, but parallel to, the hind margin. Spurs free, the longest longer than the first tarsal segment. Metasternum nearly glabrous at center, sides coarsely punctate and the hair very short and scarcely obvious.

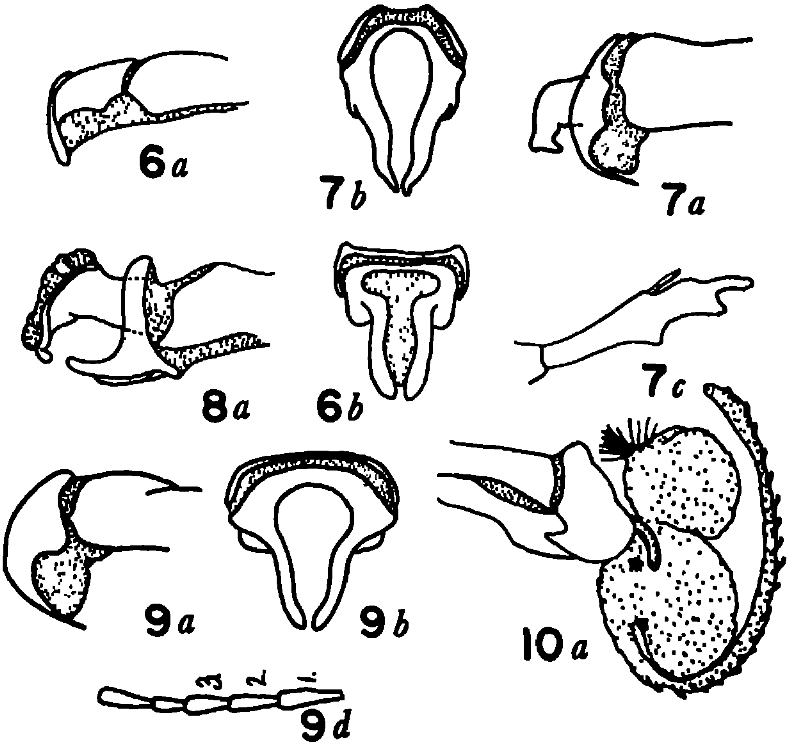

Fig 6 —*Phyllophaga spinifemora*, n sp Fig 7 —*Phyllophaga manchesterea*, n. sp Fig 8 —*Phyllophaga pseudocalcaris*, n sp Fig 9 —*Phyllophaga mandevillea*, n. sp. Fig 10 —*Phyllophaga wolcotti*, n sp *a*, Lateral view of male genitalia. *b*, En face view of male genitalia. *c*, Front tibia *d*, Dorsal view of front tarsus.

Length, 10–10.5 mm. Width, 5–5.5 mm

The *holotype* (U.S.N.M. no. 54016) and 6 paratypes, all males, were collected by E. A. Chapin and R. E. Blackwelder at Santa Crus, Jamaica, February 24, 1937, "flying at dusk." The type material, except for a pair in the Saylor Collection, is in the National Museum collection. This species is quite distinct from all West Indian species known to me and is not closely related to any of the known Jamaican species.

Phyllophaga (Phyllophaga) pseudocalcaris, n. sp. Fig. 8

Male.—Oblong-oval, shining; head and elytra with sparse and scattered short hairs, otherwise glabrous above; color testaceous to testaceopiceous, with dark castaneous cloudings on greater part of the head, thoracic disk, and on the elytral apices—entire dorsal surface in some lights with a faint metallic sheen. Clypeus short, almost rounded, but very transverse, apex not reflexed and hardly emarginate, disk densely and somewhat coarsely punctate. Front with moderately coarse, irregularly placed, moderately dense, and variolate punctures. Antenna 9-segmented, testaceous, club ovate and subequal to the preceding four segments in length. Thorax with moderately coarse, somewhat regularly placed variolate punctures, separated by one to three times their diameters; sides roundly dilated, margins entire, with sparse, short cilia; angles blunt, base margined only at sides. Elytron with moderately dense and regularly placed punctures of moderate size, surface smooth, some of the punctures with a very short scarcely obvious hair; an oblique, strialike, impunctate but not raised line on the disk, which is otherwise not striate Pygidium convex, rugose, with moderately dense punctures, disk apparently glabrous, apex ciliate and subrounded. Abdomen convex, polished; fifth sternite depressed laterally, center of base with a small, ill-defined, and transversely tumid area; sixth deeply and transversely sulcate, disk rugosely punctate. Claws almost like those of *Phytalus* but too widely cleft for that subgenus, the upper claw subapical and as long as, but thicker than, the apical claw; claw base obtusely dilated Hind spurs free and slender; lower tibial margin immediately adjacent to the shorter spur extended into a short but very obvious pseudospur. First two hind tarsal segments subequal in length. Metasternum nearly glabrous and impunctate at middle, sides moderately densely punctured, the hair short and but little evident. Hind tarsus very slightly shorter than its tibia. Upper tooth of front tibia somewhat distant from the apical two.

Length, 10 5 mm Width, 6 mm

The unique male *type* (U S N M. no. 54017) is from Rio San Juan, Dominican Republic, collected by G. S Miller in March 1938. This species is abundantly distinct from all West Indian species known to me both in the external characters and in the male genitalia.

Phyllophaga (Phyllophaga) blackwelderi, n. sp. Fig. 4

Male.—Oblong oval, polished; testaceous, with the head, thorax, and legs rufotestaceous to piceotestaceous; pygidium, thorax, and elytra apparently glabrous Clypeus with dense, coarse punctures; apex slightly emarginate, but little reflexed, the angles very broadly rounded. Front with coarse punctures and a few scattered short hairs, the punctures dense in part toward vertex but much sparser in the front half bordering the clypeal suture—vertex impunctate. Eyes large Antenna 9-segmented, unicolorous testaceous club not quite equal to the funicle. Thorax with strong and entire basal margin; sides roundly dilated, coarsely crenate and with a few cilia in apical half, and entire in basal half; disk with coarse, regularly placed, moderately sparse punctures, the latter separated by one and one-half to three times their diameters; in some specimens the disk has a small and irregular median smooth area; angles obtuse and not well indicated. Elytron subrugose, punctures slightly more dense than on thorax; striae, other than sutural, scarcely indicated, the sutural stria later becoming obsolete before reaching the elytral apex. Pygidium convex, polished, with coarse, regularly placed, moderately dense punctures, the apex rounded and ciliate. Abdomen flattened, polished, fifth sternite with coarse, setigerous punctures; sixth sternite three-fifths the length of fifth, base and apex carinate and the disk transversely flattened and punctate Metasternum coarsely, densely punctate, the hair short and not very conspicuous. Front tibia tridentate, the teeth approximately equidistant. Hind spurs free and slender, the longest one and one-half times the length of the first tarsal segment, the latter being slightly shorter than the second. Claws widely cleft, approaching closely the *Phytalus*-type; the short but sharp triangular tooth is situated very slightly beyond the middle; claw base roundly dilated. Hind tarsus subequal to the tibia.

Female.—Antennal club equal to the preceding four segments; hind tibial spurs shorter and broader than in male; last segment of abdomen flattened as in male but a little longer, the basal carina broader and less obvious; first segment of hind tarsus a little shorter than in the male and the hind tarsus in some individuals a little shorter than the tibia. Otherwise as in the male.

Length, 9–12 mm. Width, 4 5–7 mm

The *holotype* male (U.S.N M. no. 54018) and 4 paratypes are from station 234, Santa Lucia, British West Indies, collected May 15, 1936, by Dr. R. E. Blackwelder. The *allotype* female and 19 additional paratypes have the same locality and collector but were taken at station 205 on March 27, 1936. The types are in the National Museum and designated paratypes are in the Saylor Collection.

The two sexes of this species are surprisingly alike, though they can be separated by giving attention to the details of the antennae, hind spurs, and abdomen The species is not closely related to any described West Indian species. The only other species described from Santa Lucia is *brevipes* of Froelich (1792), which may not be a *Phyllophaga*, or even a rhizotrogid. In any event, *blackwelderi* differs from it in the femora being elongate and not "ovate-oblong," in the moderately tridentate not "profoundly dentate" front tibiae, and in the marginal base of the thorax, as well as in other details.

Phyllophaga (Phyllophaga) cneda, n. sp. Fig. 3

Male.—Oblong-oval, testaceocastaneous; thorax slightly dull, the beetle otherwise shining above; pygidium elytra, and thorax glabrous Clypeus short, transverse, with fine and dense punctures; apex moderately reflexed, scarcely emarginate at middle, the whole clypeal margin appearing very nearly semicircular. Front faintly impressed at middle, punctures coarser than those of clypeus, irregularly and rather sparsely placed. Antenna 9-segmented, club very slightly longer than the funicle. Thorax with complete basal marginal line, sides entire and ciliate, angles obtuse and fairly well marked; disk with moderate-sized, regularly placed punctures, separated by one and one-half to three times their diameters. Elytron with sutural stria obsolete apically and nearly so basally, otherwise unstriate; disk subrugose, with moderately dense, regularly placed punctures. Pygidium convex and polished, regularly, moderately densely, but not coarsely punctured. Abdomen slightly convex, polished; fifth sternite plane, sixth three-fourths the length of the fifth, and transversely impressed. Eyes large Claw tooth situated very nearly at the middle, claw base hardly dilated. Second segment of hind tarsus not longer than the first. Metasternal hairs very short and relatively sparse.

Length, 9.7 mm. Width, 5 mm.

The male *holotype* (U.S.N.M. no. 54019) from Montserrat Island, West Indies, collected by H. G. Hubbard, is in the National Museum. A paratype male, from "Basse Terre, St. Kitts Island, March 26," remains in the Saylor Collection. This species appears to be most closely related to *blackwelderi* Saylor and is considerably smaller than *P. montserratensis* Arrow, the only other known species from the island. From *blackwelderi* the present species may be most easily separated by the strong medium (not subapical) tarsal tooth and also by the slightly different male genitalia.

Phyllophaga (Phyllophaga) bahama, n. sp. Fig. 5

Male.—Subelongate, highly polished; color testaceous, the head, thorax, and legs rufotestaceous to rufopiceous; glabrous above. Clypeus with moderately dense and regularly placed punctures; apex widely and shallowly emarginate, angles broadly rounded, margin slightly reflexed. Front a little more sparsely punctate than the clypeus, the variolate punctures of moderate size. Antenna 9-segmented, club oval and equal to the preceding 4 segments. Thorax regularly, somewhat sparsely punctate, the umbilicate punctures separated by one to three times their diameters, base not margined; lateral margins evenly rounded, with a few cilia, not crenulate; hind angles broadly rounded and indicated only by a very slight point, front angles nearly rectangular Elytron with sutural stria obsolete basally and apically, otherwise unstriate; disk subrugose, punctures of same size and a little more dense than those of the thorax Pygidium convex, rugose, the moderately sized punctures dense and regularly placed, surface apparently glabrous. Abdomen convex, polished, nearly glabrous and very finely punctate at middle; fifth sternite with moderately dense punctures, the surface gradually declivous in apical half, which is flattened; sixth sternite three-fifths the length of the fifth, transversely impressed, and the surface very densely and not coarsely punctate Claw with a short, stubby, median tooth, claw base not obviously dilated. First segment of the hind tarsus varying from as long as, to very slightly longer than, the second Metasternal hairs moderately dense, but quite short.

Female.—Antennal club equal to either the 3 or 4 preceding segments; pygidium more flattened than in the male, and with or without very short hair; abdomen less convex, with the fifth sternite flat and the sixth slightly convex, the latter finely and moderately densely punctured in the apical three-fifths. Otherwise as in the male.

Length, 14–16 mm. Width, 8–9 mm

The *holotype* male (U.S N M. no. 54020) and *allotype* female, from "Nassau, Bahama Island, West Indies," are in the National Museum. A second pair from the same locality are in the Saylor Collection. Four additional paratypes from "Mangrove Cay, Andros Island, Bahamas, coll. May-June 1917 by Wm. Mann," agree with the types in all respects, one pair of these paratypes is deposited in the collection of the American Museum of Natural History, from whence they came, and the other is in the Saylor Collection.

P. bahama is most closely related to *P. youngi* Cartwright from Florida, but may be separated by the smaller size and the different male genitalia. The close relationship of these two species and the fact that all their characters are closely similar to those of the West Indian type, rather than the mainland type of *Phyllophaga,* give added force to the opinions of both Cartwright and myself that *P youngi* is not a very old Floridian species but rather a recent immigrant.

Phyllophaga (Phyllophaga) adjuntas, n. sp. Fig. 1

Male.—Subelongate, wider behind; testaceous to rufotestaceous, the thorax and head more rufous; surface shining, head, thorax, and pygidium glabrous. Clypeus with sparse, regularly placed punctures; apex widely and shallowly emarginate, hardly reflexed, angles broadly rounded. Front with moderately dense, irregularly placed punctures, those at the center of apex slightly smaller, vertex impunctate. Antenna 9-segmented, club subequal to funicle, segments 5 and 6 of funicle transverse. Thorax with strong basal margin and wide apical margin; hind angles subrounded, front angles subangulate; disk with moderately fine and umbilicate punctures, separated by one to three times their diameters. Elytron subrugose, punctured like thorax but more densely so, the punctures densest near base Pygidium convex, polished, fifth sternite with several coarse setigerous punctures at center. Sixth abdominal sternite a little shorter than the fifth, the basal half being a smooth but nearly flat process, widest at the middle where it is suddenly interrupted, thus forming two very blunt and dentate lobes; surface between apex, and basal and apical processes, transversely impressed and with fine punctures and sparse erect hairs, the entire sternite with a faint suggestion of a median longitudinal sulcus. Claw tooth a little stronger than apical one and situated a little beyond the middle, claw base obtusely dilated. Metasternal hair of moderate length and density. First two segments of hind tarsus subequal in length.

Female.—Antennal club equal to or slightly longer than the preceding 4 segments; sixth abdominal segment slightly convex, with fine and not dense setigerous punctures; first segment of hind tarsus shorter than the second. Otherwise as in the male.

Length, 13–15 mm. Width, 6–7 mm.

The *holotype* male from Isolina, Puerto Rico, collected on April 16, 1901, is in the United States National Museum (U S N.M. no. 54021) The *allotype* female and a paratype male, both from Adjuntas, Puerto Rico, collected May 2, 1917, at the "Fed Exp Station, Acc no. 49, 1917," are in the American Museum of Natural History, whence they came as a loan for study.

P. adjuntas does not resemble closely any known West Indian species in the type of male genitalia; externally it resembles *P. citri* Smyth but differs from that species in the nonpruinose dorsal surface, the much longer male antennal club, and the quite different male sixth abdominal segment.

Phyllophaga (Phyllophaga) mandevillea, n. sp. Fig. 9

Male.—Rufocasteneous; polished and glabrous above. Head with front convex and with a suggestion of a median longitudinal sulcus, and with rather coarse, variolate, and somewhat sparse punctures. Clypeus very short and transverse, the apical margin narrowly and very strongly emarginate, the emargination in connection with the strongly rounded angles giving the clypeus a distinctly bilobed appearance; disk coarsely and not densely punctate. Eyes large Antennae 8-segmented, the club very slightly longer than the funicle; fourth segment twice the length of third, fifth segment transverse and about one-fourth as long as fourth. Thorax with the disk variolately punctate, the punctures moderately coarse but sparse, and separated by two or three times their diameters on the center of the disk, but closer at sides; base of thorax not margined at middle, front margin very weakly indicated but entire, sides roundly dilated and entire, with sparse and very short cilia; front and hind angles obtusely subangulate.

Scutellum impunctate. Elytron with coarse, variolate punctures, surface unstriate and subrugose; sutural stria not well indicated at middle and entirely obsolete basally and apically Pygidium strongly convex, pruinose, with moderately dense, fine punctures, and short erect hair; apex subtruncate and ciliate. Abdomen polished, flattened at middle, coarsely punctured, and with sparse short hairs; fifth sternite slightly longer than fourth, middle of the apical margin with two sharp but short teeth separated from each other by a shallow emargination; sixth sternite as long as fifth, surface rugose, flattened, with coarse punctures and slightly carinate basal and apical marginal lines, each bearing a single row of rather long hairs. All claws short with the apical tooth rather strongly curved; middle tooth small, situated slightly basad from the middle and strongly inclined toward the base; basal dilation obtusely rounded. All tarsal segments with moderately dense hairy soles; first segment of each tarsus longer than the second. Front tibia strongly tridentate, the upper tooth slightly beyond the middle. Metasternum strongly, very densely, and umbilicately punctate, with very short procumbent hair; somewhat more sparsely punctate at middle All tarsi longer than their tibiae Apex of middle tibia with a strongly serrate margin; each lateral angle of the apex is somewhat prolonged into a slightly larger tooth

Female.-- Antennal club ovate, hardly equal to segments 3 to 5 combined; eyes smaller; clypeus larger than in male; pygidium more narrowed apically and the hairs longer; abdomen semiconvex and very coarsely punctate, with the apical margin of the fifth sternite plane; sixth abdominal segment slightly convex; hind tarsus distinctly shorter than the tibia; all other characters including the middle tibia, exactly as in the male

Length, 11 5 to 13 5 mm Width, 5.5 to 6.5 mm.

The *holotype* male, the *allotype* female, and a pair of paratypes are from Mandeville, Manchester, Jamaica, collected between November 16 and December 19, 1919, at altitudes between 2,131 and 2,250 feet. The holotype and allotype are deposited in the American Museum of Natural History and the paratypes in the Saylor Collection

This species is most closely related to a species (from exactly the same locality in Jamaica) that is now in manuscript by M. W Sanderson. From this species of Sanderson's the new species differs especially in having the third tarsal segment two and one-half times longer than wide (rather than only one-half longer than wide), the elytral punctures finer and evenly spaced (not confusedly punctate), the hairy "sole" of the tarsus much less dense, and the slightly different male genitalia I am indebted to Dr Sanderson for comparing my specimens with the type of his new species.

Phyllophaga (Phyllophaga) manchesterea, n. sp. Fig. 7

Male.—Castaneous, shining, glabrous above Head with front very coarsely, densely and variolately punctured, with a strong median, impressed, longitudinal sulcus. Clypeus short, the apex reflexed, narrowly and deeply emarginate and the angles rounded, the entire clypeus appearing bilobed; disk coarsely punctate. Antenna 8-segmented, club subequal to funicle; segments 3 and 4 moderately long, the fourth slightly longer than the preceding; fifth transverse. Thorax with disk variolately punctate, the punctures moderately coarse and separated by one to two times their diameters on the disk, much closer at sides and nearly contiguous at center of apex; base not margined at middle; front with strong marginal lines; sides roundly dilated, entire; angles obtrusely subangulate. Scutellum with several coarse punctures. Elytron rugose, nonstriate on disk, the punctures coarse, variolate, and moderately dense, sutural stria obsolete basally and apically. Pygidium convex, slightly pruinose, with moderately dense and very coarse punctures, and apparently glabrous except for the row of hairs at apex. Abdomen slightly flattened, coarsely punctate, with scattered short hairs; fifth sternite coarsely punctate, apical margin evenly rounded; sixth sternite half as long as fifth, and transversely impressed. All claws of moderate length, each with a very small median tooth. Hind tibial spurs free, the longest longer than the first tarsal segment. First segment of hind tarsus shorter than the second; in the front and mid tarsi the first segment is equal in length to the second. Metasternum coarsely and very densely punctate at sides and very sparsely so at center, with short and hardly obvious hair. Front tibia tridentate, the upper tooth slightly beyond the middle in position; the middle tooth is distinctly closer to the apical than to the basal tooth.

Length, 9.5 mm. Width, 4 mm.

The unique male *type* is from Mandeville, Manchester, Jamaica, collected November 30 to December 4, 1919, at an altitude of 2,131 feet, and is deposited in the collection of the American Museum of Natural History, from where it was lent for study by Dr. R. E. Blackwelder.

P. manchesterea is nearest *P. mandevillea* in general relationships but differs especially in the smaller size, tarsal claws, much less pilose tarsi, pygidial and abdominal characters, and the coarser and denser puncturation. From Sanderson's new species it differs especially in having a median tarsal claw tooth that the former lacks.

NEW NAMES

Whereas the name *Listrochelus* can not be maintained as a genus by any set of characters yet discovered[1,2] and must be considered as a subgenus of *Phyllophaga*, several specific names become homonyms, and new names are needed. Two are here proposed:

Phyllophaga (Phyllophaga) temaxa, new name

Lachnosterna parilis Bates, Biol. Cent. Amer. 2(2). 404. 1889. (Non *Listrochelus parilis* Bates, 1888, l.c., p. 172.)

Phyllophaga (Listrochelus) yaqui, new name

Listrochelus debilis Arrow, Ann. Mag. Nat. Hist. (ser. 10) 11: 145. 1933. (Non *Gynnis debilis* LeConte, 1856, non *Lachnosterna debilis* Horn, 1885.)

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[1] SAYLOR, L. W. *Necessary changes in important rhizotrogid genera.* Rev. Ent. 7: 318–322. 1937.

[2] SAYLOR, L. W. *Revision of the beetles of the melolonthine subgenus* Phytalus *of the United States.* Proc. U. S. Nat. Mus. 86 (3048): 157–167. 1939.

MALACOLOGY.—*A new urocoptid mollusk from Mexico.*[1] HARALD A. REHDER, U. S. National Museum.

Among some mollusks from the State of Nuevo Leon, Mexico, sent to the United States National Museum by E. J. Koestner, was an interesting new urocoptid, which was determined to be related to *Propilsbrya* Bartsch.

This group was created by Dr. Paul Bartsch in 1906[2] as a subgenus of *Epirobia* to include a single species *Epirobia* (*Propilsbrya*) *nelsoni* Bartsch, from the Sierra Guadalupe, Coahuila, Mexico. It differs radically from *Epirobia* in having a broader axis, an axial lamella, and a denticulate parietal lamella; moreover, it is far out of the range of the more southerly *Epirobia*. In the same publication, on page 151, Bartsch defined a new subgenus of *Holospira* under the name *Stalactella,* for the species *Holospira* (*Stalactella*) *rosei* Bartsch, from Tehuacan, Puebla, Mexico. This species has the same type of lamellae as found in *Propilsbrya* and has the same general form, but is decollate. In this group, however, the presence or absence of the early whorls is apparently not a differentiating character, as the first four or five whorls seem to be readily detachable. Among the 11 specimens of the present new species that I have been able to examine, two had the apical whorls still adherent, and in one of these the first 4 or 5 whorls dropped off during the examination of the specimen.

We therefore may unite *Propilsbrya* and *Stalactella,* retaining the first name as the generic designation for the group in question and placing it near *Holospira,* from which it differs in being slenderer and decollate and in possessing denticulate lamellae.

The shell submitted by Mr. Koestner is related to *Propilsbrya* (*Stalactella*) *rosei,* differing from it in the internal armature. For this species I propose the following new subgenus:

Pectinistemma, n. subgen

Shell of moderate size, axially ribbed, with the nuclear whorls usually deciduous. An axial lamella is present, originating anteriorly as a cord and gradually becoming broader and more lamellar, furnished in the third and fourth whorls from the last with long, flattened, rather crowded, forward-curving teeth. A strong parietal lamella is also present, originating in the fifth whorl from the last, and in the next two whorls scalloped, or bearing crowded, short, broad, flattened, forward-curving teeth.

Type.—*Propilsbrya* (*Pectinistemma*) *koestneri,* new species

This subgenus differs from typical *Propilsbrya* in the axial lamella being thin and bearing denticles and in the teeth of the parietal lamella being

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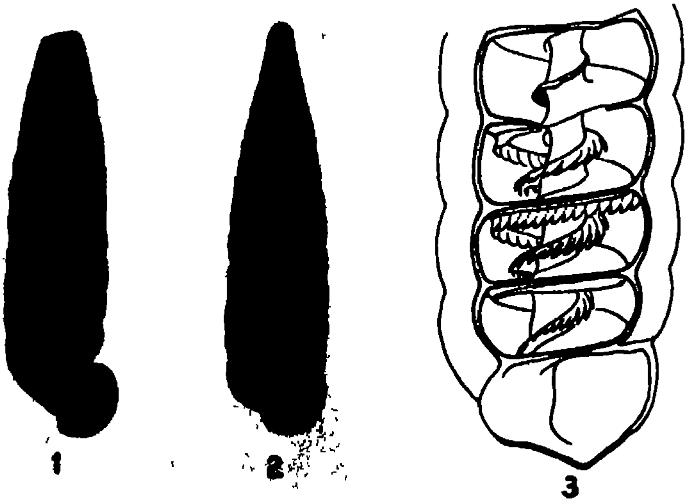
[1] Published by permission of the Secretary of the Smithsonian Institution. Received March 9, 1940.

[2] BARTSCH, PAUL. Proc U S. Nat Mus 31(1483): 121. 1906.

broader and more crowded, forming almost a thin, pendant, platelike lamella.

Propilsbrya (Pectinistemma) koestneri, n. sp. Figs. 1–3

Shell of moderate size, slender, cylindrical, gradually tapering at the apex, vinaceous-brown to bluish gray in color The nuclear whorls about 3, rather smooth, somewhat bulbous, the following 18¼ whorls rather flattened, strongly impressed at the suture, rather closely axially ribbed. The first 5 whorls are easily detachable and generally lost, so that the shell is decollate, with the minute round perforation of the hollow axis visible from above The base is evenly rounded, the axial ribs continuing into the minute umbilical perforation. The aperture is oval, the posterior portion somewhat flattened, and the lip entire, slightly reflexed. The lamellae are adequately described in the subgeneric diagnosis above Both lamellae terminate just behind the aperture and hence are not visible from the exterior, the columella showing only a slight axial swelling



Figs 1–3 —*Propilsbrya* (*Pectinistemma*) *koestneri*, n sp Fig 1 —Holotype, ×3. Fig 2.—Paratype, immature, showing nuclear whorls, ×3 Fig 3 —Internal view, showing lamellae, ×7.

The type, U S.N.M. no 535762, was collected by R A Schneider and E. J. Koestner on the Cerro Potosi at Galeana, State of Nuevo Leon, Mexico. Here it was hanging on mosses under rock outcroppings at an elevation of 12,000 feet. It, a decollate specimen, measures: Height, 17.4 mm; width, 5.0 mm.

Seven other specimens, U.S.N.M no. 535763, are from the same lot.

Three further specimens, U.S N.M. no 467392, were received some years ago from Dr S. S. Berry They were collected by S. Dickin on the north slope of Cerro Potosi at an elevation between 10,000 and 11,000 feet.

From *Propilsbrya rosei* Bartsch, described from Tehuacan, Puebla, this species differs externally in color and in the axial riblets being stronger and more crowded. It is, moreover, a larger, stouter shell, and the apical whorls are slenderer and attenuated. From *Propilsbrya nelsoni* Bartsch it differs in being a stouter shell with more flattened whorls.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE ACADEMY

360TH MEETING OF THE BOARD OF MANAGERS

The 360th meeting of the Board of Managers was held in the Board Room of the Cosmos Club on Friday, April 19, 1940 President **Crittenden** called the meeting to order at 8:02 p.m There were 19 present, as follows.

E C **Crittenden**
F D **Rossini**
F C **Kracek**
H. S **Rappleye**
G. **Steiner**
F M. **Setzler**
W. B **Bell**
A. T **McPherson**
C **Thom**
W A **Dayton**
H L **Curtis**
W **Ramberg**
E W. **Price**
C L **Garner**
H G **Dorsey**
C L **Gasin**
W W **Diehl**
and by invitation:
J H **Kempton**
R J. **Seeger**

The customary reports of the standing committees were read and accepted. H. L **Curtis**, chairman of the special committee, charged with recommending to the Board the appropriate action to be taken with respect to amending the bylaws on the subject of the offices of nonresident vice-presidents, reported his committee in disagreement but with the possibility of accord by the next meeting of the Board

M. W. **Stirling** was elected by the Board to fill the vacancy caused by the resignation of J. F. **Couch** who had been elected manager at the last election.

President **Crittenden** was authorized to appoint delegates from the Academy to the Fiftieth Anniversary celebration of the Ohio Academy of Sciences at Columbus, Ohio, May 9–11, and to the Eighth American Scientific Congress at Washington, D C, May 10–18 He was also authorized to appoint two committees—one to consider Societies eligible for affiliation with the Academy and the other to consider the question of a meeting place for the Academy when the Cosmos Club leaves its present quarters.

The Board adjourned at 10:02 p.m

ANTHROPOLOGICAL SOCIETY

The Anthropological Society of Washington at its annual meeting held January 16, 1940, elected the following officers for the ensuing year: President, **Frank M. Setzler**; Vice-president, **Julian H. Steward**; Secretary, **Regina Flannery**; Treasurer, **T. Dale Stewart**; members of the Board of Managers, **George S. Duncan**, **Herbert W. Krieger**, **Julian H. Steward**, **Ruth Underhill**, **Waldo R. Wedel**.

A report of the membership and activities of the Society since the last annual meeting follows.

Membership:

Life members	2
Active members	39
Associate members	11
Total	52
New members	5

The members elected during the year were: **William N. Fenton**, **Antonio Santa Cruz**, and **Helen Cullinane**, active members; **Walter Bart Greenwood** and **Joseph R Singer**, associate members.

The Treasurer's report is as follows:

Funds invested in Perpetual Building Association (Interest for 1939 not included)		$1,453.42
21 shares Washington Sanitary Improvement Co par value $10 per share		210.00
2 shares Washington Sanitary Housing Co. par value $100 per share		200 00
Cash in bank		576.62
		$2,440.04
Bills outstanding:		
To American Anthropological Association	$80.00	
To printer	3.75	
To Treasurer	1 93	
	$85.68	85 68
Total		$2,354.36
Total as of 1/16/39		2,171.76
Increase		$ 182.60

Papers presented before the regular meetings of the Society were as follows:

January 17, 1939, 683d meeting, **John M Cooper**, *Are the simplest living cultures representative of early prehistoric cultures?*

February 21, 1939, 684th meeting held jointly with the Smithsonian Institution on the occasion of the Eighth Arthur Lecture, **Herbert J Spinden**, *Sun worship.*

March 21, 1939, 685th meeting, **William E Cadieux**, *The Blackfoot Indians of Montana.*

April 20, 1939, 686th meeting, held jointly with the Washington Academy of Sciences, **W. M. Krogman**, *The skeleton tells its story.*

October 17, 1939, 687th meeting, **W. W. Hill**, *Economic history of the Navaho Indians*

November 21, 1939, 688th meeting, **David C. Graham**, *The customs and myths of the Ch'uan Miao of southwest China.*

December 19, 1939, 689th meeting, **John R Swanton**, *De Soto's route through the Southeast.*

Regina Flannery, *Secretary*

BOTANICAL SOCIETY

293D MEETING

The 293d regular meeting was held in the assembly hall of the Cosmos Club, December 6, 1938, President **Gravatt** presiding; attendance 70. **Rogers McVaugh**, **Brittain B. Robinson**, **Marcus M. Rhoades**, **Daniel Sullivan**, and **Claude Hope** were elected to membership.

Notes and reviews.—M. B. **WAITE** called attention to the scarlet oak, which still showed a brilliant red coloring while the usual autumnal coloring was about October 10. He also displayed a plant of Mammoth Maryland tobacco in flower which had survived two heavy frosts The tobacco crop had been harvested about the first of September. **CHARLES THOM** exhibited a new book, *Introduction to industrial mycology*, by George Smith.

Program.—**PERKINS COVILLE**: *Prairie shelter belt work of the U. S. Forest Service.*

38TH ANNUAL MEETING

The 38th annual meeting was held immediately following adjournment of the 293d regular meeting, G F. **GRAVATT** presiding.

James F. Couch read an obituary for V K **CHESNUT**; John A. Stevenson for B. T. **GALLOWAY**; Charles E. Chambliss for **FRANK LAMSON-SCRIBNER**; H. P. Barss for **FRED** C. **MEIER**; C E Leighty for **GUY** N **COLLINS**. **EMMA** F. **SIRRINE** was elected to honorary membership.

The following officers were elected for 1939: President, **CHARLES THOM**; Vice-President, **CHARLOTTE ELLIOTT**; Recording Secretary, **ALICE** M. **ANDERSEN**; Corresponding Secretary, **NELLIE** W. **NANCE**; Treasurer, **KENNETH** B. **RAPER** Nominated for Vice-President of the Washington Academy of Sciences, G. F. **GRAVATT**

294TH MEETING

The 294th regular meeting was held in the assembly hall of the Cosmos Club, January 3, 1939, President **CHARLES THOM** presiding, attendance 90. **HARRY HUMFELD** was elected to membership

Notes and reviews.—M. B. **WAITE** called attention to the fact that many tree seeds require a resting period before they will germinate, but that he had observed that the acorn of the rock chestnut oak does not require a resting period and germinates immediately upon falling to the ground. In November the roots of the seedlings were 6 inches long.

Program.—W. M. **LUNN**, D. E **BROWN**, J E **MCMURTREY**, and W. W. **GARNER**: *Tobacco and weeds.*—It was soon observed in colonial days that virgin soil produced good yields of tobacco and that the leaf had a finer texture and lighter body, better suited to the market demands of the period, than that grown on the older cultivated areas The same holds true at the present time. Consequently, in order consistently to produce the desired type of leaf the early settlers and their successors continued to clear the forested areas until in time most of the land suited to tobacco in the older tobacco-producing regions had been brought into cultivation. Subsequently, crop rotation and the use of manures and fertilizers have been tried in an effort to maintain yields and quality on old land but these practices have not proved satisfactory on all soils and with all crop combinations.

It is clearly evident from the results presented that tobacco that is fertilized intelligently and grown after natural weed fallow of sufficient duration possesses in a large measure those characteristics which were early observed in the crop grown on virgin land. The crop grown after bare fallow has shown a rapid decline in yield and gross value, demonstrating that the cover of spontaneous vegetation is the keystone of the system rather than simply allowing the land to remain idle.

The tests conducted with individual weed and crop plant species have consistently shown that certain species are much more desirable than others. Ragweed and horseweed as the preceding cover crop have produced marked increases in yields and especially in values of the tobacco crop over results obtained from bare fallow. On the other hand, following lamb's-quarters the tobacco crop has actually shown reductions in yields and value as compared with bare fallow. In these tests annual lespedeza has shown no advantage as a cover crop to precede tobacco, sweet clover, rabbit's-foot clover, and wild pea have not always shown a decided advantage, while partridge pea has produced some increase in yield. While the natural weeds occurring in these tests consisted principally of those species in pure stands which produced high quality leaf, it is possible that the ones found to be objectionable might predominate under some conditions, with a resulting harmful effect on the succeeding tobacco crop. It is hardly to be expected that a given weed species would have the same effect on tobacco on all soils or under all conditions.

The general beneficial effect of the weed fallow was the promotion of a quick start and very rapid and uniform growth of the tobacco plants from transplanting time to maturity. Within normal limits this result is, in turn, associated with a uniformly high market value per acre and average price per pound which demonstrates that the resulting product meets current demands for most manufacturing purposes.

J. H. MARTIN: *Cleaning 20 million bushels of seed grain* (lantern).—Average grain from the spring-wheat States contains more than 2 percent by weight of weed seeds, chiefly wild oats, mustard, and pigeon grass. Nearly 20 million bushels of Government-owned wheat, oats, barley, and flax were cleaned for seeding in drought-stricken areas in 1934–35. Seed separation by mechanical means is possible when the seeds differ appreciably in specific gravity, length, or thickness. The most complete separations are accomplished by means of pocketed discs or indented cylinders when seeds differ in length. Suction separates better than air blasts. Mustard seeds roll over screen perforations and are difficult to separate completely from grain. Quackgrass seeds could not be separated completely from oats or flaxseed. Mechanical cleaning increased the test weight of wheat slightly, barley considerably, and oats remarkably, but reduced that of flaxseed by roughening the seed coats and preventing close packing.

ALICE M. ANDERSEN, *Recording Secretary.*

JOURNAL
OF THE
WASHINGTON ACADEMY OF SCIENCES

VOL. 30 AUGUST 15, 1940 No. 8

PALEONTOLOGY.—*Seven new genera of Carboniferous Crinoidea Inadunata.*[1] EDWIN KIRK, U. S. Geological Survey.

A considerable number of inadunate crinoids with turbinate dorsal cups, three anal plates in the cup, and with varying arm structures have been described from the Carboniferous. In earlier years these species were, as a rule, described as *Poteriocrinus* or *Scaphiocrinus.* Latterly many of them have been referred to *Pachylocrinus* or *Scytalocrinus.* The assignment has been based primarily on whether the arms divide above the first dichotom. A study extending over a number of years of practically all the described species and a considerable series of undescribed species has shown that such a casual grouping obscures both the biologic and stratigraphic relationships of the crinoids. In some cases, owing to the poor quality of the types and uncertainty of accurate placement of well-preserved material, description of the genera will have to wait upon description of adequate specific material.

In forming these inadunate genera and others to be established, consideration has been given to all known species and large numbers of undescribed species. It may seem at times that some of the genera are too closely circumscribed. However, one must either use the inclusive genera of the past with stratigraphic ranges in some cases from the Silurian to the Carboniferous, or attempt to delimit phyletic groups that have real stratigraphic and genetic significance. Hundreds of complete crowns are available for study in the museums. These give pertinent information as to ontogenetic development and permissible variation in structures. In the case of most genera they also furnish adequate phylogenetic series.

Blothrocrinus, n. gen.

Genotype.—Poteriocrinus jesupi Whitfield.

Generic diagnosis.—

Crown. Very high, widening gradually distad, then gradually contracting.
Dorsal cup. Turbinate; plates smooth.
IBB. High, forming an appreciable amount of the cup wall.
BB. Large.

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[1] Published by permission of the Director, Geological Survey, U S. Department of the Interior. Received March 19, 1940.

RR. Large; articulating facet full width of R, slightly curved, suture not gaping.

IBr. Two in all rays except anterior (irregularly one IBr in early species); in ant R, IBr range in number from 3 (one specimen) to 14 as seen, the average being about 10.

Arms The arms are very long, rounded, and with slightly cuneate brachials. In earlier species and in some of the later ones the arms are endotomous, with two or three divisions above the primaxil. In some species the first admedian ramus divides, giving approximately isotomous arms but leading toward para-endotomy.

Post IR. Three anal plates in cup, RA large, penetrating between the post B and r post B to about one-half their height; X large, meeting post B on wide, horizontal face, about one-half the plate rising above the level of the RR. RT large, extending well above level of RR

Ventral sac. The ventral sac is imperfectly known. A portion of ventral sac with fragments of arms was identified by Springer (1900) as *Blothrocrinus swallowi* According to this, the ventral sac was long and slender and made up of fragile plates, plentifully pierced with pores along their margins Another specimen, a partial set of arms, shows a portion of the sac similar to that figured by Springer. The sac extended nearly to the tips of the arms.

Column. Circular in section with pentagonal lumen.

Characteristic species of the genus —

Blothrocrinus cultidactylus (Hall), n. comb.

Poteriocrinus cultidactylus Hall, p. 62, 1860. "Base of the Burlington limestone, near Hamburgh, Illinois."—Worthen, p. 301, pl. 30, fig. 1, 1883.

Poteriocrinus (*Scaphiocrinus*) *cultidactylus* Wachsmuth and Springer, p. 114 (337), 1880

Scaphiocrinus cultidactylus Wachsmuth and Springer, p 237 (161), 1886

Blothrocrinus jesupi (Whitfield), n. comb

Poteriocrinus jesupi Whitfield, p. 7, pls 1, 2, 1881. "Burlington limestone, Burlington, Iowa " (Upper Burlington)

Pachylocrinus jesupi Springer, p. 71, 1926.

Scaphiocrinus swallowi (Meek and Worthen) (pars). (Cited as synonym of.) Wachsmuth and Springer, p. 235 (159), 1886.

Blothrocrinus spartarius (Miller and Gurley), n. comb.

Poteriocrinus spartarius Miller and Gurley, p. 37, pl. 7, fig. 1, 1890a. "Kinderhook, Le Grand, Iowa." (Hampton formation.)

Pachylocrinus spartarius Springer, p. 71, 1926.—Laudon and Beane, p. 254, pl. 19, fig. 5; pl. 18, fig. 2, 1937.

Poteriocrinus scopae Miller and Gurley, p. 38, pl. 7, fig. 2, 1890a.

Poteriocrinus genista Miller and Gurley, p. 38, pl. 7, fig. 3, 1890a.

Blothrocrinus swallowi (Meek and Worthen), n. comb.

Poteriocrinus swallovi Meek and Worthen, p. 397, 1860 —Meek and Worthen, p. 183, pl. 16, figs. 4a, b, 1866. "Burlington limestone, Burlington, Iowa." (Upper Burlington.)

Poteriocrinus (*Scaphiocrinus*) *swallovi* Wachsmuth and Springer, p. 114 (337), 1880.

Geologic and geographic distribution —*Blothrocrinus* as known ranges from the Kinderhook to the Burlington-Keokuk "transition beds" of the Mississippi Valley.

Relationships —In its arm pattern *Blothrocrinus* resembles *Pachylocrinus*, the only described genus with which it can be compared. The presence of numerous IBr in the anterior ray and the long, slender rami of *Blothrocrinus* as against the consistent two IBr and short rami of *Pachylocrinus* are the more obvious differences in arm structure The turbinate dorsal cup of *Blothrocrinus* is in marked contrast to the depressed bowl-shaped cup of *Pachylocrinus* The ventral sac of *Blothrocrinus* is long and slender, while that of *Pachylocrinus* is relatively short and stout

Remarks.—It has been the custom to identify all large *Blothrocrinus* from the upper Burlington as *swallowi* Meek and Worthen *Blothrocrinus jesupi*, here chosen as genotype, may or may not be synonymous with *swallowi*. The original description and the poor figure of the badly preserved type of *swallowi* make it impossible to identify the species with certainty. It has seemed wise to choose the splendid specimens used as types of *jesupi*

Cydrocrinus, n gen

Genotype.—*Poteriocrinus coxanus* Worthen

Generic diagnosis.—

Crown. Of medium height, compact, expanding gradually to about three-fourths its height, then contracting

Dorsal cup. Broadly turbinate, cup plates relatively thin, unornamented.

IBB. Large, making up an appreciable amount of the cup.

BB. Large

RR. Articulating facet full width of the R, slightly crescentic Suture not gaping

IBr Two in all rays (variation possible in ant R, as apparently in the type specimen of *C concinnus*, the only case known).

Arms Para-endotomous, that is, each half-ray is endotomous Two to three divisions in each half of the half-ray, giving a great number of closely crowded rami. Br wedge-shaped to cuneate. Pinnules long, moderately stout.

Post IR. RA large, pentagonal, not entering deeply between the post and r post BB. X large, extending well above the level of the R. RT smaller.

Ventral sac. Unusually broad and stout, composed of large plates with radiating ridges, nodose, but not spinous The sac has a height of about three-fourths or three-fifths the height of the crown

Column. Circular in section, lumen pentalobate.

Characteristic species of the genus.—

Cydrocrinus concinnus (Meek and Worthen), n. comb.

Poteriocrinites (*Zeacrinus?*) *concinnus* Meek and Worthen, p. 26, 1870.—Meek and Worthen, p. 490, pl. 14, fig. 3, 1873. (Called *Zeacrinus concinnus* in explanation of plate.) "Keokuk, Crawfordsville, Indiana." (Upper Borden.)

Poteriocrinus (*Pachylocrinus*) *concinnus* Wachsmuth and Springer, p. 116 (339), 1880.

Cydrocrinus coxanus (Worthen), n. comb.

Poteriocrinus coxanus Worthen, p. 4, 1882. "Upper part of Keokuk limestone, Hamilton, Illinois."—Worthen, p. 269, pl. 27, fig. 1, 1883.
Scaphiocrinus coxanus Wachsmuth and Springer, p. 237 (161), 1886.
Pachylocrinus coxanus Springer, p. 71, 1926

Cydrocrinus subramulosus (Worthen), n. comb

Poteriocrinus subramulosus Worthen, p 14, 1882.—Worthen, p. 284, pl. 27, fig. 6, 1883. "Keokuk limestone, Keokuk, Iowa "
Poteriocrinus (*Scaphiocrinus*) *swallovi* Meek and Worthen (pars) (Cited as synonym of) Wachsmuth and Springer, p. 237 (161), 1886.

Geologic and geographic distribution.—The genus as known ranges from the upper Burlington of Iowa (undescribed species) to the upper Borden of Indiana and Keokuk of Iowa

Relationships.—Superficially *Cydrocrinus* most nearly resembles *Blothrocrinus*. The relatively short, compact crown of *Cydrocrinus*, with its numerous rami, as against the very long, slender crown of *Blothrocrinus* is a most obvious difference. In *Cydrocrinus* all rays normally have two IBr against the numerous IBr in the ant R of *Blothrocrinus* The relatively short, very stout ventral sac of *Cydrocrinus*, composed of large heavy plates, is in marked contrast to the long, slender, fragile sac of *Blothrocrinus* The turbinate cup and para-endotomous arms of *Cydrocrinus* are in marked contrast to the depressed cup and endotomous arms of *Pachylocrinus*.

Ascetocrinus, n. gen.

Genotype —*Scaphiocrinus rusticellus* White

Generic diagnosis —

Crown. Tall, slender, compact, expanding slowly to about three-fourths its height, then contracting.
Dorsal cup. Subturbinate, with flattened base. Pits at angles of plates. Very fine linear ornamentation
IBB. Small, practically concealed by column, but showing in side view.
BB. Medium size.
RR. Large; articulating facet extending full width of R, linear to slightly crescentic; suture slightly gaping.
IBr. One in all rays, high, deeply constricted medially.
Arms. Long, slender, endotomous Two or three divisions above the primaxil. In one specimen in one ray the first admedian ramus divides. Br high, with marked lateral shoulders for support of pinnules, giving the ramus a *Decadocrinus*-like zigzag appearance. Pinnules long, slender.
Post IR. RA large, pentagonal, seated well down between post and r post BB. X large, extending upward well above the radial facet RT large, lying mostly above the level of the radial facet.
Ventral sac. Slender, composed of about eight vertical series of plates on the posterior side, with pores at angles. Sac about one-half the height of the arms, recurved.
Column. Stellate in section in proximal position; pentagonal, with concave faces, changing to circular in section going distad. Nodals prominent. Lumen pentagonal.

Characteristic species of the genus.—

Ascetocrinus rusticellus (White), n. comb.

Scaphiocrinus rusticellus White, p. 505, 1863. 'Lower division of the Burlington limestone, Burlington, Iowa."—Keyes, p. 212, pl. 26, fig. 1, 1894.
Poteriocrinus (*Scaphiocrinus*) *rusticellus* Wachsmuth and Springer, p. 113 (338), 1880.
Abrotocrinus rusticellus Springer, p. 72, pl. 16, fig. 11, 1926

Ascetocrinus whitei (Hall), n. comb.

Scaphiocrinus whitei Hall, p 306, 1861 —Hall, p. 7, 1861a "Burlington limestone, Burlington, Iowa." (Lower Burlington.)
Poteriocrinus whitei Wachsmuth and Springer, p. 112 (337), 1880. "Lower Burlington limestone."

Geologic and geographic distribution —Known at present only in the lower and upper Burlington limestones of Iowa

Relationships.—Springer (1926, p. 72) referred *Ascetocrinus rusticellus* to *Abrotocrinus* Miller and Gurley. *Abrotocrinus* he defined as a *Pachylocrinus* with a pentagonal column, this character being "not a very reliable one." As a matter of fact, *Abrotocrinus* is a well-characterized genus *Ascetocrinus* differs from *Abrotocrinus* in many respects. The compact, narrow crown of *Ascetocrinus* is in marked contrast to the irregular, expanded crown of *Abrotocrinus*. In *Abrotocrinus* there are many IBr in the ant R as against the single IBr in *Ascetocrinus* The dorsal cup of *Ascetocrinus* is much less depressed than that of *Abrotocrinus* The ventral sac in *Abrotocrinus* is stout, expanded in its apical portion, and usually spinous. The sac of *Ascetocrinus* is very slender, short, and delicate.

Hypselocrinus, n. gen.

Genotype —*Poteriocrinus hoveyi* Worthen

Generic diagnosis —

Crown. Very high, slender

Dorsal cup. High, narrowly turbinate.

IBB. High, making up an appreciable part of the dorsal cup

BB. Large; r post B supporting RA on its upper sloping shoulder; post B supporting X and RA.

RR. Large; articulating facet full width of the R, linear.

IBr. One in all rays, except anterior Ant ray one IBr or atomous. IBr long, constricted medially in earlier forms, slightly constricted, broad and shorter in later species (two IBr exceptionally found in one or two rays).

Arms. Very long, slender, typically not dividing above main dichotom (irregular divisions of rami rarely noted in upper Borden). Ant ray typically atomous, in some species dichotomous. Br cuneate. An adult specimen of *Hypselocrinus hoveyi* with a cup 1.7 cm in height has arms 25 cm long. Pinnules long, slender.

Post IR. Three anals in cup; RA high on upper shoulders of post and r post BB; X large, extending well above level of r post R. RT approximately one-half within the cup.

Ventral sac. Long, slender, composed of 10 or more vertical series of hexagonal plates, wider than high. Sac six to seven times the height of the cup. A ventral sac 9.8 cm in length has a width of but 1.2 cm.

Column. Circular in section.

Characteristic species of the genus.—

Hypselocrinus arcanus (Miller and Gurley), n. comb.

Poteriocrinus arcanus Miller and Gurley, p. 29, pl. 5, fig 4, 1890. "Keokuk Group, Washington County, Indiana."

Hypselocrinus boonvillensis (S. A. Miller), n comb

Poteriocrinus boonvillensis S. A Miller, p. 42, pl. 8, figs 3, 4, 1891 "Keokuk Group, Booneville, Missouri."

Hypselocrinus calyculus (Hall), n. comb.

Poteriocrinus calyculus Hall, p. 553, pl 9, figs 6a–c, 1858 "Burlington limestone, Burlington, Iowa "—Hall, pl. 2, fig. 11, 1860

Scaphiocrinus calyculus Hall, pl 6, fig 1, 1872.—Wachsmuth and Springer, p. 120 (345), 1880

Hypselocrinus douglassi (Miller and Gurley), n comb.

Poteriocrinus douglassi Miller and Gurley, p. 83, pl. 5, figs. 16, 17, 1896a. (Madison limestone.)

Decadocrinus douglassi Laudon, p. 68, pl. 7, fig 7, 1933

Hypselocrinus hoveyi (Worthen), n. comb

Poteriocrinus hoveyi Worthen (in Worthen and Meek), p. 516, pl. 29, fig. 6, 1875. "Keokuk, Crawfordsville, Indiana " (Upper Borden.)

Scytalocrinus hoveyi Springer, p 145, pl. 16, fig. 8, 1900

Poteriocrinus (*Scytalocrinus*) *robustus* (Hall) (pars) —Wachsmuth and Springer, p. 118 (343), 1880

Hypselocrinus maccabei (Miller and Gurley), n. comb.

Poteriocrinus maccabei Miller and Gurley, p 34, pl 3, figs. 3–6, 1894. "Kinderhook Group, Le Grand, Iowa." (Hampton formation)

Scytalocrinus maccabei Laudon and Beane, p 258, pl. 17, fig. 13; pl. 18, figs. 6, 7; pl 19, fig 6, 1937.

Poteriocrinus maccabei var. *decrepitus* Miller and Gurley, p. 36, pl. 3, figs. 9–12, 1894.

Poteriocrinus hammondi Miller and Gurley, p 35, pl. 3, figs 7, 8, 1894.

Hypselocrinus macrodactylus (Meek and Worthen), n. comb.

Poteriocrinites (*Scaphiocrinus*) *macrodactylus* Meek and Worthen, p. 140, 1869. "Lower Burlington, Burlington, Iowa."—Meek and Worthen, p. 415, pl. 2, fig. 9, 1873.

Poteriocrinus (*Scytalocrinus*) *macrodactylus* Wachsmuth and Springer, p. 117 (342), 1880.

Hypselocrinus neglectus (Miller and Gurley), n. comb.

Poteriocrinus neglectus Miller and Gurley, p. 31, pl. 4, figs. 3–5, 1896. "Keokuk Group, Booneville, Missouri." (Warsaw.)

Hypselocrinus pleias (Hall), n. comb.

Poteriocrinus pleias Hall, p. 8, 1863 —Hall, p. 57, 1864.—Hall and Whitfield, p. 173, pl. 12, fig. 8, 1875. "Waverly group, Richfield, Summit county, Ohio."

Poteriocrinus (*Decadocrinus*) *pleias* Wachsmuth and Springer, p. 119 (342), 1880.

Hypselocrinus tethys (Meek and Worthen), n. comb.

Poteriocrinites (*Scaphiocrinus*) *tethys* Meek and Worthen, p. 143, 1869. "Upper Burlington, Burlington, Iowa."—Meek and Worthen, p. 419, pl. 2, fig. 13, 1873.—Wachsmuth and Springer, p. 114 (339), 1880

Geologic and geographic distribution.—As known, the genus ranges from the upper Burlington to the upper Borden.

Relationships —*Hypselocrinus* among described genera most nearly resembles *Scytalocrinus*. *Scytalocrinus* has relatively short, stout arms as against the long, relatively slender rami of *Hypselocrinus* In *Scytalocrinus* the IBB lie in a depression in the species with bowl-shaped dorsal cups and are barely visible in side view in the campanulate species In *Hypselocrinus* the IBB are prominent and high They form an appreciable part of the cup. The ventral sac of *Hypselocrinus* is very long and slender. In *Scytalocrinus* the sac is short and relatively stout.

Remarks.—It does not seem desirable to separate those species with two rami in the anterior radius from the typical form with a single ramus. Atomous and dichotomous anterior radii are both found in such compact genera as *Scytalocrinus* and *Decadocrinus*, while in *Graphiocrinus* arm reduction is carried outside the anterior radius, and one specimen has but seven rami. In *Phanocrinus* of the Chester one or more species show but five rami in a usual 10-rami genus, and in other species an occasional ray, usually the anterior, is atomous In this case there could be no valid excuse for separating the forms generically

Sladen (1878, p 245) proposed the new genus *Dactylocrinus pro D. loreus* n. sp =*Poteriocrinus tenuis* Austin *non* Miller The generic name had been preoccupied by Quenstedt (1876). The genotype is obviously a very young individual and its affinities uncertain Such characters as are shown in the poor illustrations are essentially those of *Hypselocrinus*. The adult crinoid may have been quite different, however.

Poteriocrinus fusiformis Hall is referable to this genus. The name was preoccupied by Roemer, but no new name should be proposed. The species was based on a dorsal cup and IBr only and may well be identical with *Hypselocrinus macrodactylus* (Meek and Worthen).

Histocrinus, n. gen.

Genotype.—*Poteriocrinus* (*Scytalocrinus*) *grandis* Wachsmuth and Springer

Generic diagnosis —

Crown. Compact, high.

Dorsal cup. Subturbinate, plates thin, smooth, or with faint radial plications.

IBB. Well exposed in side view.
BB. Medium size.
RR. Articulating facet slightly crescentic, extending nearly the full width of the R. Suture not gaping.
IBr. Two in all rays except anterior. Ant ray two IBr or atomous.
Arms. Moderately stout, composed of cuneate brachials Arms dichotomous except in anterior ray, which may be dichotomous or atomous (typical.) The Burlington species alone of the known species is dichotomous in the anterior ray. The pinnules are moderately stout and stand out stiffly from the ramus.
Post IR. RA is large, resting subequally on post and r post BB. X is of about the same size as RA and extends well above the level of the RR. RT is smaller and lies almost entirely above the level of the RR.
Ventral sac. The ventral sac is subcylindrical, expanding slightly distad. The tube is reflexed, carrying the tip of the sac and the anal opening well down on the anterior side. On its posterior side the sac shows five vertical series of plates. This is one of the genera in which Springer (1900, p. 144) demonstrated the presence of pores in the ventral sac. The plates at the distal recurved portion of the sac are tumid to subspinous.
Column. The column is circular in section and made up of prominent series of nodals and internodals.

Characteristic species of the genus —

Histocrinus grandis (Wachsmuth and Springer), n. comb.

Poteriocrinus (*Scytalocrinus*) *grandis* nom. nov. pro *Poteriocrinus coreyi* Worthen 1875, non *Poteriocrinites* (*Scaphiocrinus*) *coreyi* Meek and Worthen 1869.—Wachsmuth and Springer, p 118, 1880.
Decadocrinus grandis Wachsmuth and Springer, pl. 7, figs 4, 5, 1897. (The figures are, however, *Decadocrinus tumidulus* (Miller and Gurley).)
Poteriocrinus coreyi Worthen (in Worthen and Meek), p. 516, pl. 29, figs. 2, 3a, b, 1875.

Histocrinus graphicus (Miller and Gurley), n. comb.

Scaphiocrinus graphicus Miller and Gurley, p 50, pl. 10, fig 4, 1890. "Keokuk Group, Crawfordsville, Indiana." (Upper Borden)

Histocrinus juvenis (Meek and Worthen), n comb.

Poteriocrinites (*Scaphiocrinus*) *juvenis* Meek and Worthen, p. 146, 1869 "Lower Burlington, Burlington, Iowa."—Meek and Worthen, p. 417, pl. 2, fig. 8, 1873.
Poteriocrinus (*Decadocrinus*) *juvenis* Wachsmuth and Springer, p. 119 (342) 1880.

Geologic and geographic distribution.—The genus as known is found in the Burlington and Keokuk of the Mississippi Valley and the Borden of Indiana.

Relationships.—*Histocrinus* combines characters diagnostic of the unrelated genera *Decadocrinus* and *Hypselocrinus*. The erect, stout arms with their heavy comblike pinnules are similar to those of *Decadocrinus*. The subturbinate cup, the relatively thin, smooth cup plates, and the large prominent IBB could fall under *Hypselocrinus*. The ventral sac is structurally like *Decadocrinus* but is relatively shorter. The presence of two IBr, the character of the arms, and the more turbinate cup distinguish *Histocrinus* at once from *Scytalocrinus*.

One must consider the possibility of intergeneric crosses among the crinoids. This is by no means the only instance of combined generic characters suggesting such a cross.

Phacelocrinus, n. gen.

Genotype.—Poteriocrinus wetherbyi S. A Miller.

Generic diagnosis.—

Crown High, subcylindrical or spreading distad.

Dorsal cup. Subturbinate to campanulate.

IBB High, making up an appreciable part of the dorsal cup.

BB. Medium size; r post B supporting RA; post B supporting X and RA.

RR. Large; articulating facet full width of R, slightly crescentic, suture gaping

IBr. Two or fusing irregularly to one compound brachial, though suture can often be seen In both cases the compound brachial is very high and deeply constricted medially

Arms. Two undivided rami to the ray is typical. In some of the Chester specimens irregular branching occurs. Br cuneate, with long, slender pinnules The maximum length of arms seems to be about six or seven times the height of the cup.

Post IR Three anal plates in cup. RA penetrates well down between post and r post BB. X extends above level of RR, sometimes separated from post B in the Chester forms. RT mostly out of the cup.

Ventral sac. Cylindrical, with a maximum height of about four times that of the cup. Composed of vertical series of hexagonal plates of nearly the same height and breadth.

Column. Pentagonal in section.

Characteristic species of the genus —

Phacelocrinus bisselli (Worthen), n. comb.

Poteriocrinites bisselli Worthen (in Meek and Worthen), p. 546, pl. 21, fig. 4, 1873. "Chester, Chester, Illinois."

Poteriocrinus (*Scytalocrinus*) *bisselli* Wachsmuth and Springer, p. 117 (340), 1880

Phacelocrinus columbiensis (Worthen), n. comb.

Poteriocrinus columbiensis Worthen, p. 22, 1882. "Chester limestone, near Columbia, Monroe county, Ill." (Renault.)—Worthen, p. 293, pl. 29, fig. 6, 1883.

Decadocrinus columbiensis Wachsmuth and Springer, p. 239 (163), 1886.

Phacelocrinus dactyliformis (Hall), n. comb.

Scaphiocrinus dactyliformis Hall, p. 670, pl. 17, fig. 6, text fig. 105, 1858. "St. Louis limestone: St. Louis, Missouri."

Poteriocrinus (*Scaphiocrinus*) *dactyliformis* Wachsmuth and Springer, p. 112 (335), 1880.

Phacelocrinus decabrachiatus (Hall), n. comb.

Scaphiocrinus decabrachiatus Hall, p. 679, pl. 25, fig. 1, text fig. 106, 1858. "Kaskaskia limestone: Kaskaskia, Illinois." (St. Louis limestone *fide* Worthen, 1883.)

Poteriocrinus (*Scytalocrinus*) *decabrachiatus* Wachsmuth and Springer, p. 117 (340), 1880.

Phacelocrinus gracilis (Troost), n. comb.

Agassizocrinites gracilis Troost, p 420, 1849. (Nom. nud.)—Troost, p. 62, 1850. (Nom. nud.)—Troost, p. 88, pl. 11, fig. 9, 1909.

Scytalocrinus? gracilis Wood (in Troost), p. 88, 1909. "St. Louis limestone. Huntsville, Alabama." ("Ste. Genevieve.")

Phacelocrinus internodius (Hall), n. comb

Scaphiocrinus internodius Hall, p. 679, pl. 25, fig. 2, text fig. 107, 1858. "Kaskaskia limestone: Chester, Illinois." (St. Louis limestone *fide* Worthen, 1883. Possibly Ste. Genevieve) Wachsmuth and Springer, p. 113 (336), 1880.

Phacelocrinus longidactylus (McChesney), n. comb.

Scaphiocrinus longidactylus McChesney, p. 7, text fig., 1860. "Kaskaskia division of the Carboniferous limestone, Kaskaskia, Illinois."—McChesney, pl. 4, fig 4, 1865—McChesney, p. 4, pl. 4, fig. 4, text fig., 1868. "Chester division of the sub-carboniferous limestone, Kaskaskia, Illinois."

Poteriocrinus (*Scytalocrinus*) *decabrachiatus* Hall. (Cited as synonym of.) Wachsmuth and Springer, p. 117 (340), 1880.

Phacelocrinus vanhornei (Worthen), n. comb.

Poteriocrinus vanhornei Worthen (in Worthen and Meek), p 517, pl. 31, figs. 2, 3, 1875. "Upper division of St. Louis group, Alton, Illinois."

Poteriocrinus (*Scytalocrinus*) *vanhornei* Wachsmuth and Springer, p. 118 (343), 1880.

Scytalocrinus vanhornei Keyes, p. 213, pl. 26, fig. 3, 1894.—Springer, p. 145, pl. 16, figs. 13, 14, 1900

Poteriocrinus arrectarius Miller and Gurley, p. 33, pl. 4, fig. 6, 1896.

Phacelocrinus wachsmuthi (Wetherby), n. comb.

Scytalocrinus wachsmuthi Wetherby, p 155, pl 5, fig. 4, 1880. "Kaskaskia (Chester) Group, Pulaski county, Kentucky." (Glen Dean.)—Wachsmuth and Springer, p. 238 (162), 1886

Phacelocrinus wetherbyi (S. A. Miller), n. comb.

Poteriocrinus wetherbyi S. A. Miller, p. 36 (6), pl. 8, figs. 1, 1a, b, 1879. 'Kaskaskia, Pulaski county, Kentucky." (Glen Dean.)

Poteriocrinus (*Scytalocrinus*) *wetherbyi* Wachsmuth and Springer, p. 118 (343), 1880.

Geologic and geographic distribution.—*Phacelocrinus* ranges as known from the St. Louis to the upper middle Chester (Glen Dean) of the Mississippi Valley, Alabama and Kentucky. An undescribed species is known in the Greenbrier of Maryland.

Relationships.—*Phacelocrinus* in its simplicity of form resembles *Hypselocrinus*. No one, after handling specimens of the two genera, would have difficulty separating them, even in the case of dorsal cups. The arms of *Phacelocrinus* are relatively shorter and stouter than in *Hypselocrinus* in comparing similar stages in phylogeny. In *Phacelocrinus* the IBr are either clearly two in number or have fused into a high, compound brachial, deeply constricted medially. This lack of fusion of the two plates is very apparent in the St. Louis species, though the degree of fusion varies among the rays of the same specimen Even in the Chester, however, either through incomplete fusion or fracture on the suture, the compound nature of the brachial is often seen In *Hypselocrinus* there is but a single primibrach, and when occasionally a variation showing two primibrachs is found in one or two rays, the second is obviously an additional brachial The gaping articulating sutures of *Phacelocrinus* are in marked contrast to the close union in *Hypselocrinus* as usually seen The column in *Phacelocrinus* is pentagonal in section, as against the round column of *Hypselocrinus* The ventral sac of *Phacelocrinus* is relatively shorter and composed of larger plates than in *Hypselocrinus*.

Pegocrinus, n. gen.

Genotype —*Poteriocrinus bijugus* Trautschold.

Generic diagnosis —

Crown High, compact, arms attaining a length 15 times or more that of the dorsal cup

Dorsal cup Broadly turbinate Plates thick.

IBB Small, partially anchylosed into a firm disk, clearly visible in side view. Sutures well shown.

BB. Variable in size and shape, barely meeting laterally or on very short faces The post B is high and narrow, supporting RA on its long, upper right shoulder Above it barely meets anal X. R post B is large, supporting RA on a narrow face

RR Large. Articulating facet the full width of the R. Suture not gaping The upper surface of the R is very deep. There is a prominent fulcral ridge and a deep ligament pit. There is a large, well-defined pair of muscular fossae The apposing edges of the R and IBr along the suture are strongly crenulate.

IBr. Variable in number without respect to the rays. Two or three in number, usually two

Arms. Long and massive, two undivided rami to each ray. Br low, quadrangular or with slightly sloping faces, each bearing a long, stout pinnule. Food groove shallow, no axial canal. Margins of Br crenulate.

Post IR. RA small, elongate, narrow. Anal X small, high, narrow. RT small, in some cases barely contacting RA.

Ventral sac. Poorly known. One specimen shows the partially dissociated plates in approximately their original position. According to this, the sac is short, erect, and fairly stout in relation to the dorsal cup. The plates are small and thin, forming a fragile structure.

Column. Circular in section, with stellate lumen.

Characteristic species of the genus.—

Pegocrinus bijugus (Trautschold), n. comb.

Poteriocrinus bijugus Trautschold, p. 14, pl. 4, figs. 1–3, text fig., 1867. Junger Bergkalk (Moscovian), Miatschkowa, Russia.—Trautschold, text fig., 1879.—Jaekel, p. 64, fig. 54a, 1918.

Poteriocrinus (*Scytalocrinus*) *bijugus* Wachsmuth and Springer, p. 118 (343), 1880.

Geologic and geographic distribution.—The genus is known at present only in the Moscovian (Pennsylvanian) of Russia.

Relationships.—There seems to be no described genus with which *Pegocrinus* may be confused. Two poteriocrinoid genera associated with *Pegocrinus* are readily distinguished, although one of them was apparently confused with it by Trautschold Both *Moscovicrinus* and *Ophiurocrinus* have high, rather narrowly turbinate dorsal cups as against the broadly turbinate cup of *Pegocrinus* The IBB of *Pegocrinus*, meeting on very narrow faces and practically anchylosing into a solid disk, are in marked contrast to the high IBB of the other two genera The patterns of the plates of the posterior IR are unlike. *Moscovicrinus* has branching arms and a remarkable circinate ventral sac, both wanting in *Pegocrinus*.

Of the original specimens figured by Trautschold (1867, pl. 4), specimen figure 2 was sent by Trautschold to Wachsmuth and is now in the Springer collection in the United States National Museum Jaekel (1918, p. 64, fig 54a) states that his figure is from the "holotype" in Breslau It could not be either specimen figures 2 or 3. Owing to the great number of inaccuracies in this work of Jaekel, it is doubtful that it really represents any one of the three specimens of Trautschold At any rate, Jaekel does not indicate which specimen he chose as type. Owing to the uncertainties of the matter, I have chosen specimen figure 2, plate 4, of Trautschold (1867) as holotype.

The specimen figured by Trautschold (1879, pl. 14, fig. 3) as *Poteriocrinus bijugus* is certainly not that species. It probably is referable to *Poteriocrinus originarius*, for which Jaekel erected the genus *Ophiurocrinus*

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BOTANY.—*The wild bean* Phaseolus polystachyus (*L.*) *B.S.P.: Its chromosome number.*[1] H. A. ALLARD and H. F. ALLARD, U. S. Department of Agriculture.

Eleven species of beans of the genus *Phaseolus* are known to be more or less generally cultivated in various parts of the world, all of tropical, subtropical, or warm-temperature origin and sensitive to frost. Considerable work has been done by various investigators to determine the chromosome number of the cultivated species, as reported by J. Kawakami in his paper, *Chromosome numbers in Leguminosae* (Bot. Mag. Tokyo **44**: 319–329. 1930). It appears that in all our well-known species of beans of the genus *Phaseolus*, 22 chromosomes is the somatic or $2n$ number. Among those reported are the species *P. acutifolius*, *angularis*, *aureus*, *coccineus*, *lunatus*, and *mungo*, as well as varieties of some of these. *Dolichos lablab* also has $22 = (2n)$ chromosomes, as reported by Karpetschenko (1925) and Kachidse (1925).

In the Eastern United States from Connecticut southward to the Gulf, a native wild bean (*Phaseolus polystachyus*) occurs, which is of considerable interest in some of its behaviors. Although stated otherwise in Gray's *Manual of botany* and other botanical works, a characteristic of its germination is the hypogean life of its cotyledons, whereas the cotyledons of most of our beans have an epigean history. The Scarlet Runner bean (*P. multiflorus*), however, is an exception to this, like the wild bean.

The senior writer has found this bean to be an occasional constituent of the flora of the lower mountain areas of Virginia, within the Upper Piedmont physiographic province, and he has studied its ecology and length-of-day behaviors in some detail.

It is eminently unsuited to tropical lengths of day of 12 hours or less and to the winter conditions of daylight in the greenhouses of our northern latitudes. Under such conditions its growth is so slow that it becomes a much dwarfed and practically a dormant plant, devoid of the typical twining habit, and producing few or no flowers.

The rootstock of this bean is perennial, the aerial stems dying down to the ground, where, under favorable conditions of protection, winter buds are formed that originate the new stems of the next summer. The laying down of dormant buds and the gradual dying of the aerial parts at the close of the summer season are nicely adjusted behaviors dependent upon shortening days and lowering mean temperatures.

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[1] Received February 1, 1940.

The suppression of vegetative elongation together with normal flower production when the days are sufficiently shortened artificially represents extremes of this late-summer behavior. As a matter of fact, when germination takes place in the greenhouse in winter time, the seedling plants remain very small and almost dormant, tending to produce thickened rootstocks with the downward translocation of material. It would appear that there can be no utilization in upward elongation and flowering as in the summer season of long days and high mean temperatures.

In nature the wild bean in the upper Piedmont area is ecologically a plant of deciduous woodlands and warm well-drained rocky slopes. It will grow readily in the open in rich garden soils, however, and remain in a flourishing condition until autumn arrives, but the roots readily freeze and rot in wet, unprotected garden soils.

Cold, wet, exposed soils and the aggressions of vigorous competitors do not favor the survival of this bean in open grassland fields and pastures. Even in the woodland environment of the Piedmont uplands, where it is driven, its scarcity would indicate precarious conditions of survival.

A study of the chromosome number of this bean was made by the junior author, and the *n* number of the pollen mother cells was found to be 11. The somatic ($2n$) number, then, is 22, which, as previously stated, is that of all our common garden varieties reported upon by Kawakami. The chromosomes of the wild bean are of small size.

On the basis of the constant chromosome number of the species of *Phaseolus*, so far as such determinations have been made, this genus appears to be a relatively stable one. It might also be assumed that it is of more recent evolution, without marked specialization in this direction as yet, owing in part perhaps to uniformity of habitat.

There is reason to believe that the genus is definitely of warm-climate origin, since the center of distribution is within the Tropics. Those beans that have been investigated have been shown to grow and to flower readily in response to lengths of day of 12 hours or less, thus adapting them to tropical and subtropical conditions of daylight. Some species and varieties, in addition, are able to flower in response to the much longer days of high latitudes. In this respect these beans are either indeterminate in their day-length requirements or are short-day plants with very high critical length-of-day limitations that favor flowering far north of the Tropics.

Other species or varieties of beans are more rigidly confined to the

Tropics or to low latitudes, owing to the narrow limits of their length-of-day adaptations.

Several tropical lima beans (*Phaseolus lunatus*) from Peru (F.S.P.I. no. 46153) and Ecuador (F.S.P.I. no. 46339) reported upon in 1920 by Garner and Allard[2] were found to be unable to flower in the latitude of Washington, D. C., owing to the fact that these were short-day plants with a rather narrow range of lengths of day favorable to flowering. In other words, these beans were adapted only to tropical lengths of day or to those lengths of day of low latitudes, so far as sexual reproduction was concerned.

A bean of the species *Phaseolus multiflorus*, also from South America, reported upon by Garner and Allard[3] in 1923, showed a similar tropical short-day behavior, since it could not flower at Washington, D. C., when long days were experienced, but was induced to flower late in summer with 10 hours of daylight afforded each day. This variety, also, when afforded only 10 hours of daylight, showed a marked reduction in aerial stem growth and the roots became strikingly tuberiferous (loc. cit., pl. 6). With 12 hours of light there was less tuberization, and with exposure to the full length of the summer day, and likewise to artificially lengthened winter days, by the use of electric light, there was none.

The native wild bean of the eastern North American territory can be definitely excluded from the tropical category. This bean, with its present constitutional inability to grow and to fruit on lengths of day around 12 hours or less, could not well have originated in the Tropics or in equatorial regions. There is reason, then, to believe that it is a somewhat isolated outlying offshoot of the great tropical group, since it not only must have the greatly increased lengths of day of higher latitudes to persist, but its greater resistance to winter cold than most beans can withstand is an additional adaptation for the habitat of a temperate climate.

[2] Garner, W. W , and Allard H. A. *Effect of the relative length of day and night and other factors of the environment on growth and reproduction in plants.* Journ. Agr. Res. 18(11): 600. 1920

[3] Garner, W W , and Allard H. A *Further studies in photoperiodism, the response of the plant to relative length of day and night.* Journ. Agr. Res 23(11): 893. 1923.

MYCOLOGY.—*A ringworm disease of muskrats transferable to man.*[1]

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In the fall of 1936 a culture of a fungus apparently pathogenic to man was received from Dr. Paul L. Errington, of Iowa State College of Agriculture and Mechanic Arts. Dr. Errington had been working with muskrats (*Ondatra zibethica*) near Ruthven, Iowa, which were affected with a serious skin disease. The culture was made from his arm, which had become infected with a type of ringworm, and as the infected arm was the one he had habitually used in examining nests of muskrats and handling the young, it occurred to him that he might have contracted the disease affecting the muskrats. The culture submitted was somewhat old and contained only one type of spores, which were small and 1-celled, suggesting the microconidia of a ringworm fungus. The culture was transferred to Sabouraud and cornmeal agar, and in the course of 3–5 weeks developed other types of organs and spores characteristic of the genus *Trichophyton.*

APPEARANCE ON MAN

The appearance of ringworm was first observed by an assistant who spent July 4, 1935, on the marsh helping to capture for tagging the more active sizes of young animals. In this case definite "rings" appeared on her legs. While this would seem a more unlikely place than exposed arms, the work of helping capture the animals for tagging often necessitated her wading in the water about the lodges, and in this manner infection could have easily taken place.

Dr. Errington describes the history of his own case as follows:

> On June 24, 1936, I noticed a glazed-appearing area about 20 mm in diameter on the back of my left hand; by the next day this was almost completely surrounded by an inflamed ring. A similar area was to be seen higher up on my arm and a smaller one near the elbow. My left arm was usually more or less scratched, as it was the one I used in digging into and feeling around in the muskrat lodges in connection with my research. I had handled badly diseased animals on several occasions during the preceding two weeks and had been in the habit of washing thoroughly in soap and water and touching recognized scratches with iodine each evening after coming in from the field.
>
> The evening of June 25, I applied a salve extensively used for the treatment of burns, etc., but by morning the two eruptions were enlarged and itching. I went to a local physician, who gave me three different ointments to try, none of which proved more than partially efficacious. These were, I think, preparations containing salicylic acid, but the thick greasy base evidently prevented really effective penetration. The result was that salves strong enough to have even a superficial effect blistered my skin severely

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[1] Received February 5, 1940.

> and yet did not seem to reach the organisms intrenched at the base of the hairs; at any rate, whenever I would try to give my skin a rest, fungus activity would start up again.
>
> I had occasion to make a trip to Ames about July 8 and while there called on two other physicians. By this time, I was in misery, with 32 square inches of my left arm involved either by the fungus or dermatitis from the salve. One of the physicians directed me to pull out the hairs on the raised fungus infected areas and to keep the arm wet-packed with an aqueous solution of allantoin and also to apply 2 percent allantoin and 1-10,000 phenyl mercuric nitrate in a greaseless base as an ointment. The almost intolerable itching was relieved, and, in a few days, the troublesome areas consisted only of the raised foci of the fungus infection. These foci, however, remained unyielding to treatment prescribed so far and were four in number, namely, two raised rings, 35 mm in diameter on back of hand and lower arm, a solid raised area 20 mm in diameter near the elbow, and a fourth area of about 8 mm at the base of the little finger. All were firm or hard to the touch and dark red, the larger ones being purplish red and spotted by pus pockets.

It was Dr. Errington's experience that there was an apparent difference in the effectiveness of a penetrating solution and a thick salve even when salicyclic acid was the active chemical used in both. He stated in a subsequent letter that on occasions of suspected exposure he had washed his hands in 1:500 aqueous solution of mercuric iodide, which appeared to give protection.

APPEARANCE OF ANIMALS

Dr. Errington reported that during the midsummer of 1935 a considerable number of young muskrats under observation on Round Lake near Ruthven were found to be suffering heavy mortality from a skin disease:

> Advanced cases were marked by underweight, by watery swollen pustules on ventral surface or by hairlessness about legs, base of tail and under-parts. Incipient cases in individuals of apparently normal size and health may at times be detected by a slight baldness or dandruff-like scurf on head or back or possibly by one or a few watery blisters on the end of the tail (4). [Later he wrote] A skin disease (I think it is only one but there may be more) affecting young muskrats has been found in about 10 percent of the litters examined. When the disease is represented in a litter, usually a third to a half of the members are affected, though sometimes the whole litter. Mortality seems to be complete if the muskrats contract the disease while less than ten days old; larger young may recover, little the worse for the experience except perhaps for a slightly bobbed tail.
>
> In very young animals, the disease seems characterized by dermatitis pustules, usually on the underparts. Young thus affected typically cease growing and soon disappear. In animals of around two weeks, pustules are seldom seen except on the bare scaly tails, but either a dry, dandruff-like scurf may be noted or a localized loss of hair, especially about the extremities, underparts, and base of tail. This sort of case is commonly attended by stunted growth and ultimate death. When fairly large young have only a blister or two on the tail the case is not so likely to be serious, but some

animals with only this slight degree of visible infection may become stunted and die also.

It is believed that only one organism was involved in the skin disease of the muskrats because only one organism was consistently found in the material submitted for examination, and in the cultures isolated from the skin and hair of diseased animals. All the other fungi that appeared in culture or were present on the fresh material were clearly secondary. A species of *Fusarium* was observed in one culture, but it is not thought that a species of this genus would produce the clinical symptoms presented in this case.

ISOLATION OF THE FUNGUS

The first specimen of muskrat material was received by the writer in January 1937 and consisted of a dry skin of a muskrat that had been affected by a ringworm fungus but had recovered from the attack. Cultures were made from this skin, but no pathogenic fungus was recovered. As the season for work with very young muskrats had passed, the mycological studies had to wait until the following year. In May 1938, Dr. Errington reported that in his study of muskrats in the area near Ruthven, Iowa, he had found no evidence of muskrat skin disease, but that he had expectations of finding infected animals late in June or in July, when past experience indicated that the trouble would be more widespread and conspicuous. Anticipating this reappearance of the disease, tubes of culture media were forwarded to Dr. Errington in order to enable him to make cultures direct from the animals in the field. This supposition proved to be correct, and in the later part of June 1938 cultures made from skins of diseased muskrats from Round Lake, Iowa, were sent to the author. Six cultures were received at this time, but no pathogenic organism was found, although the cultures were made from the scurf. However, this may have been due to the fact that the work in the field presented many opportunities for contamination by vigorous but nonpathogenic fungi. Still believing that a species of *Microsporum* or a related fungus was the cause of the trouble, the writer requested more cultures from diseased animals, and on July 14 and 16 twelve additional cultures were received. One culture made from hairs from the bare foot of a muskrat, removed by heat-sterilized tweezer-tips, was suggestive of *Trichophyton*, and after being cultured it proved to belong to this genus. When this culture was received it contained only microconidia, but transfers made to other culture media developed a striking polymorphism. The original culture was found to be exceedingly vigorous and grew luxuriantly on various culture media. Cultures were also made from a small dried piece of skin from a diseased muskrat. Pure, vigorous growths of the fungus were obtained from these isolations.

TERMINOLOGY OF CERTAIN STRUCTURES IN THE DERMATOPHYTES

The polymorphic character of many human and animal fungus pathogens has led to a more or less specialized terminology of the different organs. In order to avoid any confusion the terms employed in this paper may be defined as follows:

Thyrse, a contracted paniclelike spore bearing structure.

Microconidia (*Aleurospores*) may be acrogenous or pleurogenous and are borne in thyrses. They are small, 1-celled, and spherical to oval or clavate in shape The term aleurospore has been applied to these spores and is employed in most papers on medical mycology. They are generally produced in large numbers and when they predominate impart a powdery appearance to the surface of the culture.

Macroconidia are referred to as closterospores or fuseaux They are elongate, septate, and thin or thick walled. The ends are blunt, and the base is broad and encircled by a collar, which marks the point of attachment to the conidiophore Constrictions are sometimes evident at the septa.

Chlamydospores, so-called, may be formed in the hyphae or they may be terminal. They do not possess the thick wall characteristic of true chlamydospores and when intercalary resemble the vesiculose cells of species of the genus *Fusarium*.

Arthrospores are rows of undifferentiated hyphal cells, which function in the distribution of the fungus and in carrying it over periods of unfavorable conditions.

Nodular organs may resemble haustoria in shape or may appear as a tangle of hyphae resulting from a number of short branches near the tip of the hyphae.

Spirals are produced from vegetative hyphae and may consist of loosely or tightly coiled hyphae with smooth thin walls It has been suggested that these structures may be connected with an ascogenous stage, but this has not been demonstrated. Spirals occur in several species of Dermatophytes and are not regarded as characters useful in the taxonomic distinction of species.

CULTURAL CHARACTERS

The organism from muskrats was grown in culture for over a year and a half. On solid media the early cultures produced a powdery growth at first white, later becoming cream. On liquid media the growth was more cottony, although microconidia were developed rather abundantly. Subsequent cultures during the course of some 15 months showed less tendency to form macroconidia and other organs but continued to produce microconidia in abundance. An exception to this rule was observed in the case of cultures grown on egg-meat broth. The original culture was made on Sabouraud and transferred to egg-meat on September 24, 1938, on which it produced a white, fluffy growth at the surface of the medium, an abundance of microconidia but no coils. Transferred to Sabouraud on November 10, 1939, the growth was rapid, vigorous, and characteristically polymorphic, producing microconidia, macroconidia, and short coils. It is interesting to note that after this length of time and after transfer to semiliquid media and return to solid media (Sabouraud) the macroconidia were noticeably longer and more septate than in the original cultures or in the cultures grown continuously on solid media. These cultures had been kept in an ice-box at a temperature of about 40°F. for a period of a year.

TABLE 1.—TYPE OF GROWTH ON NINE MEDIA

Medium	Type of growth	Microconidia	Macroconidia	Spirals	Color of medium
Blood serum	Growth felty when later powdery	Abundant on sides of walls in young cultures	Present, 3-4 septate	Absent	No change.
Corn-meal agar	Growth scanty; chlamydospores well developed	Abundant	Absent	Present but few and not highly developed, about 3-4 coils	Not colored
Sabouraud	Cottony at first later powdery, chlamydospores present	Abundant slightly larger and less uniformly spherical than in growth on other media	Present; in young cultures 2-3 celled	Weak development	Reverse of medium wine red when old
Rice	Growth rapid at first, pure white, finally cream, aerial mycelium in cultures carried over one year remained white	Abundant	Few, 2-3 celled	Numerous	Back of old cultures tan
Potato dextrose	Growth white, cottony, finally powdery at top of culture, luxuriant development of chlamydospores.	Abundant	Fair development of blunt 4-septate conidia	Absent	Little change, back of old cultures dark
Brain veal	Mycelium luxuriant, chlamydospores abundant	Numerous	Blunt or slightly pointed	Absent	No change.
Egg-meat	Growth at top of culture fluffy, white	Numerous (aerial spores smaller)	Absent.	Absent	No change.
Rosenau Dext brain broth	Growth mostly at surface of medium, white then cream; chlamydospores few	Numerous	Few, mostly 5-septate	Few, short	
Phenol-red tartrate agar. .	Growth white	Abundant	Fair, development, mostly 3-septate.	Absent	Little change.

IDENTITY OF THE FUNGUS

As mentioned in the introduction the cultures isolated by Dr. Errington from his arm and from the muskrat after numerous culture studies were determined as belonging to the genus *Trichophyton* according to Emmon's classification. This author (3) recognizes three groups of Dermatophytes, which are closely related but may be separated by the distinctive types of macroconidia that they form in culture. These three types are represented by the following genera:

Trichophyton (Malmsten, 1845) (6).
Epidermophyton (Sabouraud, 1907) (8).
Microsporum (Gruby, 1843) (5).

In the genus *Trichophyton* the mycelium is generally hyaline though it may be yellow, violet, or even brown. The reproduction is principally by small conidia, the so-called microconidia. The macroconidia are clavate and thin-walled but are not always formed and are generally absent in old cultures or those that have been repeatedly transferred.

The genus *Epidermophyton* is characterized by the oval to egg-shaped, smooth, thick-walled macroconidia. The mycelium is usually yellow.

Species of the genus *Microsporum* are easily determined by the mostly numerous, spindle-shaped, thick-walled macroconidia and the clavate conidia. In certain species of this genus, however, the macroconidia may be few or abortive. The mycelium is generally hyaline, or according to certain authors it may range from hyaline to brown.

The organism isolated from the muskrat and grown over a period of 1½ years in pure culture conformed to the generic characters of the genus *Trichophyton* and was identified as *T. mentagrophytes* (Robin) (7) Blanchard (1).

The identity of the two organisms, the one isolated from man and the other from muskrats, was proved by comparative cultural studies. All probable sources of the case of human infection other than the muskrats were eliminated. It was observed that the strain obtained from the muskrat produced a much more rapid and vigorous growth than the one isolated from man. The longevity of the former organism was also much more marked.

A very similar case of the occurrence of this fungus on an animal host has recently been described by DeLamater (2) on common gray squirrels living on or near the Johns Hopkins University Campus at Baltimore. The author described the virulence of the fungus on squirrels and stated that cats and rabbits were shown to be susceptible to the strain and in two cases accidental infection of human subjects occurred. There was no mention of any mortality of the squirrels.

As far as our information goes this is the first report of *T. mentagrophytes* on muskrats. This occurrence is not only of interest because of the economic importance of the host, but because it presents another record of the transference of an animal parasite to man.

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PALEOBOTANY.—*New species and changes of name in some American fossil floras.*[1] ROLAND W. BROWN, U. S. Geological Survey.

Information uncovered by the writer during the past few years involves a number of new species that seem worthy of immediate report, new occurrences of described species that shed further light on the floras in which they occur, and changes of name demanded by unequivocal evidence. In the study of the material assembled here the writer has been aided in part by the generous cooperation of W. R. Maxon, of the National Herbarium; H. A. Gleason and colleagues, of the New York Botanical Garden; J. B. Reeside, Jr., of the Geological Survey; F. M. Carpenter, of Harvard University; and D. I. Axelrod, National Research Council Fellow.

OSMUNDACEAE

Osmunda occidentale (Berry) Brown, n. comb. **Fig. 1**

Asplenium occidentale Berry, 4, p. 236, pl. 49, figs. 3, 4.
Fern fragment. Knowlton, 25, p. 24, pl. 9, fig. 10.
Pteris sp. Berry, 4, p. 237.—Idem, 6, p. 103.

When compared with the pinnules of the royal fern, *Osmunda regalis*

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[1] Published with the permission of the Director, Geological Survey, United States Department of the Interior. Received February 28, 1940.

Linnaeus, these specimens show such close resemblance that little doubt as to their being *Osmunda* can be entertained. This identification harmonizes with the general ecological setting of these floras

Occurrence —Latah formation, Washington and Idaho. Also lake beds in the Lemhi Valley, Baker, Idaho (Fig. 1)

POLYPODIACEAE

Adiantum anastomosum Brown, n. sp. Fig. 2

Frond or pinna 10 cm or more in diameter, strongly cordate at the base; deeply lobed Lobes apparently 8, long, narrow, of unequal length, lygodioid in form. Venation without a midrib, reticulate, anastomosing freely Sori on the margins of the lobes narrow, in discontinuous patches Margin entire.

Except for the more cordate base, this frond is almost identical with that described by Gardner and Ettingshausen (19, p. 42, pl. 11, fig. 1) as *Hewardia regia*, from the middle Eocene Middle Bagshot beds at Bournemouth, England Hollick (21, p. 41, pl. 6, figs. 1–5) has described what seems to be a species of this genus as *Anthrophyopsis hamiltonensis*, but it has ligulate or lanceolate foliage However, as no sori are present, there is no positive assurance that Hollick's specimens are related to *Adiantum*.

Botanists regard *Hewardia* as a section of *Adiantum*. The fossil species may be compared with a number of living species, but there is no complete agreement with any. *Adiantum cordatum* Maxon, from Panama, has cordate pinnae with entire margins, no tendency to lobing, and with a distinct midrib. *Adiantum wilsoni* Hooker, from Jamaica, is similar to *cordatum* but has smaller, more numerous pinnae, with serrate margins. *Adiantum adiantoides* (J Smith) Christensen, from Guiana, is similar to *wilsoni*, but the pinnae are not serrate. *Adiantum olivaceum* Baker, from Guiana, has disjunct sori, giving the margins of the pinnae a toothed appearance.

The close correspondence between *Adiantum anastomosum* and *Hewardia regia* suggests a comparison of the two fossil floras of which these ferns are members. The Bagshot beds at Bournemouth, according to a citation by Reid and Chandler (29, p. 84) of the work so far done by Dr. Helen Bandulska on the cuticles of leaves from these beds, carry, besides the ferns—*Chrysodium, Asplenites, Glossochlamys, Podoloma, Meniphyllum, Osmunda, Pteris, Phegopteris, Gleichenia, Lygodium, Hewardia, Aneimia, Adiantum*—and *Nipa*, described by Gardner and Ettingshausen, species of the following genera: *Araucarites, Sequoia, Taxodium, Aniba, Neolitsea, Litsea, Lindera, Cinnamomum, Nothofagus, Rhodomyrtus*, and *Tristania*.

Compared with this list, the flora from Steel's Crossing, Wash., not yet completely identified, has the following: *Adiantum, Woodwardia, Equisetum, Sequoia, Ulmus* or *Zelkova, Cercidiphyllum, Ptelea, Dillenites, Acer*, and *Platanus*.

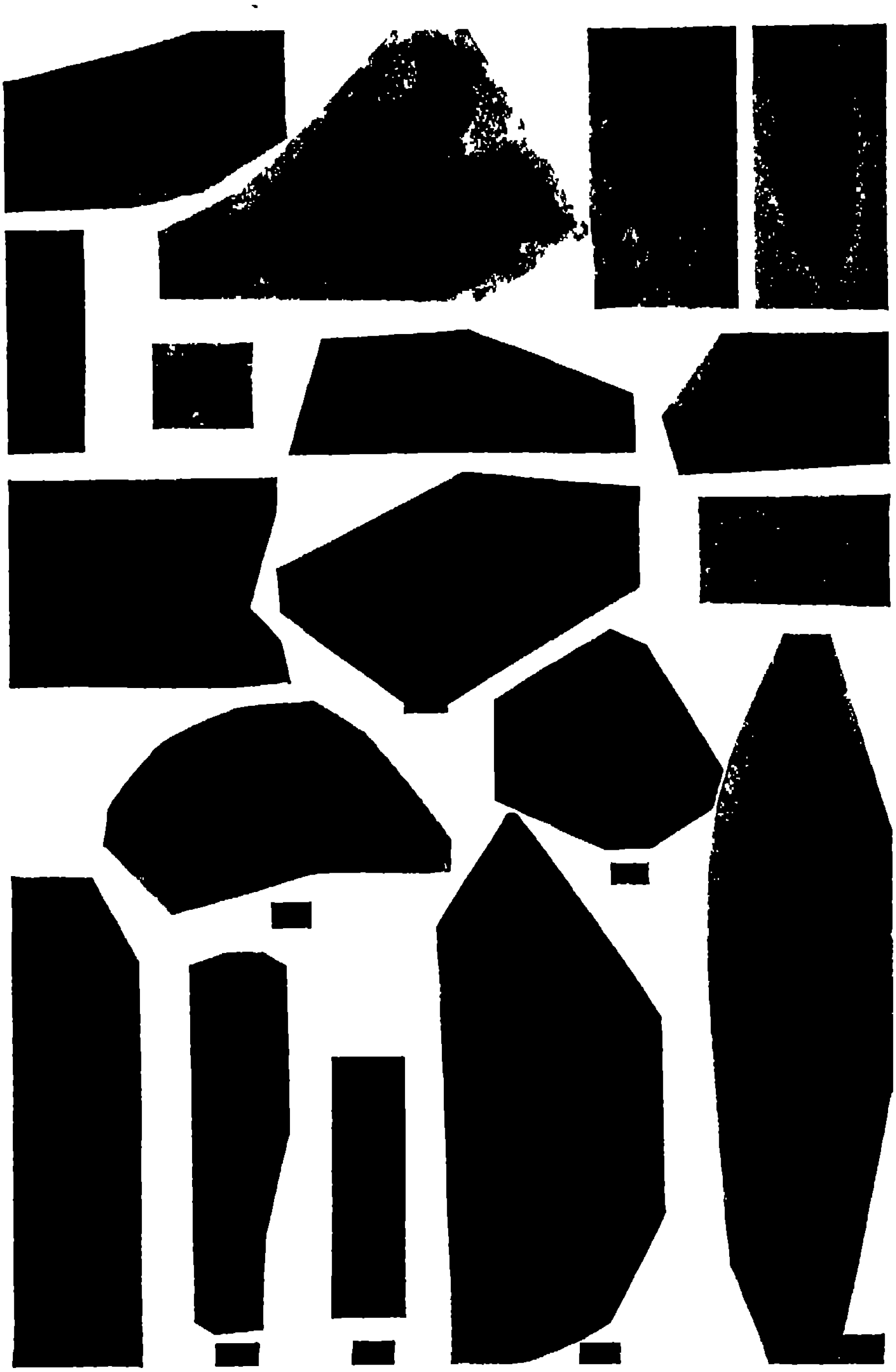
Occurrence.—In light-colored, grayish to buff shales at Steel's Crossing, 3 miles west of Renton, Wash. Upper Eocene.

Pteris idahoensis (Knowlton) Brown, n. comb.

Dryopteris idahoensis Knowlton, 22, p. 721, pl. 99, figs. 1, 2.
Pteris calabazensis Dorf. Smith, 33, p. 467, pl. 12, fig. 2.

The venation and habit displayed by these specimens are those of *Pteris*, a species tentatively regarded as different from *P. silvicola* Hall (Chaney, 13, p. 100, pl. 8, figs. 2, 4–7) from Crooked River, Oreg.

Occurrence.—Marsh, Idaho. Payette formation.



Figs 1-18 (See opposite page for legend)

PINACEAE

Abies chaneyi Mason

Abies chaneyi Mason, 28, p. 149, pl. 4, fig. 2 [not other figures].
Abies magnifica var. *shastensis* Lemmon. Mason, 28, p. 150, pl 4, fig. 6.

Although Mason compared the cone scale of *Abies chaneyi* with that of the living *venusta*, he noted that the bract of this scale lacked the basal lateral appendages of *venusta*. The scale itself is twice as wide as it is long, whereas those of *venusta* are only a little wider than they are long. Furthermore, if a *venusta* scale with bract were to occur as a fossil the bract would scarcely display the wide, expanded base seen in the fossil figured by Mason; it would appear more like those called *Abies longirostris* Knowlton from Creede, Colo., although here also reservations should be made when comparing with *venusta*. The second scale figured by Mason and compared with *shastensis* appears to the writer to belong to the same species as the first but has had the long point of the bract broken off. The shape of these scales does not compare favorably with that of *shastensis*, but the writer has no other suggestion to offer, except that this fossil species may not have been in the direct line of either *venusta* or *shastensis* but may have ended without further issue

Occurrence.—Mascall formation, John Day basin, Oreg.

Abies concoloroides Brown, n. sp.

Abies chaneyi Mason Brown, 10, p 167, pl. 45, figs 23, 24.
Abies chaneyi Mason, 28, p. 149, pl 4, figs. 1, 7, foliage [not other figures].
Abies magnifica var. *shastensis* Lemmon Mason, 28, p 150, fig 5.

Mason compared the foliage of *Abies chaneyi* with that of the living *venusta* but pointed out differences, notably that the needles are slenderer than those of *venusta*. Another significant difference is the strong curvature, which *venusta* does not display. The needles of the living *concolor*, however, match this foliage very well. The seed, here synonymized, can also be duplicated by seeds of *concolor*. That several species of fir are represented in the fossils from the Mascall and related formations is quite likely.

Occurrence.—Mascall formation, John Day basin, and Blue Mountains, Oreg.

Callitris potlatchensis Brown Fig. 6

Callitris potlatchensis Brown, 9, p. 575, pl. 67, fig. 16.

This species was first reported from the Latah formation on Potlatch Creek, Idaho. An unremitting search for foliage to confirm the identification of these seeds has so far failed to produce anything satisfactorily comparable with the foliage of the living species.

Occurrence.—Gray ranch, on Crooked River, Oreg Specimen collected by Richard Mote, Corvallis, Oreg.

Fig. 1.—*Osmunda occidentale* (Berry) Brown, n. comb. Fig. 2.—*Adiantum anastomosum* Brown, n. sp. Fig. 3.—*Eucommia montana* Brown, n sp. Fig. 4.—*Eucommia ulmoides* Oliver, a living species from central China. Fig. 5—*Fraxinus flexifolia* (Lesquereux) Brown. Fig. 6—*Callitris potlatchensis* Brown Figs. 7, 8.—*Acer knowltoni* (Berry) Brown, n. comb Fig. 9.—*Tetrapteris simsoni* Brown, n. sp. Fig. 10.—*Engelhardtia olsoni* Brown, n. sp. Fig. 11.—*Banksites lineatus* Lesquereux. Fig. 12.—*Porana speirii* Lesquereux. Fig. 13—*Porana tenuis* Lesquereux.—Figs. 14, 15.—*Potamogeton heterophylloides* Berry. Fig. 16.—*Potamogeton parva* Brown, n. sp. Fig. 17.—*Dipteronia insignis* (Lesquereux) Brown. Fig. 18—*Umbellularia eocenica* Brown, n. sp.

Pseudolarix americana Brown, n. sp.

Picea sp. Brown, 10, p. 167, pl. 45, fig. 8.

At the time this cone scale was tentatively reported as that from a species of *Picea*, its resemblance to the scales of the golden larch, *Pseudolarix kaempferi* Gordon, of eastern China, was noted. Although foliage to confirm the identification has not yet been collected, or at least not recognized, it seems to the writer now that this scale should be definitely referred to *Pseudolarix*.

Occurrence—Republic, Wash. Probably lower Miocene.

NAIADACEAE

Potamogeton heterophylloides Berry Figs. 14, 15

Potamogeton sp. Knowlton, 25, p. 29, pl. 10, figs. 5, 6.
Potamogeton heterophylloides Berry, 4, p. 240 [not pl. 50, figs. 1–3, which are *Keteleeria heterophylloides* (Berry) Brown]

Fig. 14 shows a linear, somewhat spatulate, floating leaf and Fig. 15 a linear, submerged leaf of a species of pondweed. Margins entire. Venation of the floating leaf 6–8, thin, parallel veins, with delicate cross-veinlets; that of the submerged leaf is an intramarginal vein with reticulate connections to the midrib. In Knowlton's Fig. 6, which is a two times enlargement of Fig. 5, the venation is retouched and shown as a series of parallel veins The venation, however, is like that shown here in Fig 15, and indicates that Knowlton's leaf was a submerged, not a surface leaf. These leaves can be matched readily by those from a number of living species.

Occurrence.—Latah formation, Spokane, Wash. Both specimens were collected by Kentworth Buxton, of Spokane.

Potamogeton parva Brown, n. sp. Fig. 16

A small, linear-elliptic, floating leaf of a pondweed Principal veins parallel, delicate, and at their basal origin, closely appressed to the midrib. Cross-veinlets scattering, indistinct.

Occurrence.—Gray Ranch, Crooked River, Oreg. Oligocene. Specimen collected by Charles B Read, U S. Geological Survey

FAGACEAE

Castanopsis perplexa (Knowlton) Brown, n. comb.

Castanopsis convexa (Lesquereux) Brooks, 7, p. 288, pl 6, fig 5; pl. 10, figs 1, 3; pl 12, figs 1–6; pl. 13, figs 4–6, pl. 18, figs 3–5; pl. 20, fig. 4; pl. 21, fig. 1b Omit first three items of the synonymy and fig. 7 of the fourth item —Brown, 10, p. 171, pl. 49, figs. 8–11.—Dorf, 17, p. 112, pl. 1, figs. 7, 8.—Smith, 32, p. 112, pl. 2, fig. 7; pl. 5, fig. 7
Quercus browni Brooks, 7, p. 291, pl. 14, figs. 5, 6 [not figs. 3, 4, 7, 8].—Smith, 32, p. 112, pl. 2, figs. 3, 4
Quercus treleasii Berry. Smith, 32, p. 113, pl. 6, fig. 2.
Rhododendron idahoensis Smith, 33, p. 180, pl. 13, figs. 6, 10.

Axelrod (2, p. 95) identifies as *Quercus* the types upon which Brooks based her combination, and considers the Sucker Creek, Oreg., and allied *Castanopsis* material as different from *Castanopsis chrysophylloides* Lesquereux, from Chalk Bluffs, Calif. A new name is therefore required for the Sucker Creek specimens, and those from other localities subsequently identified as the same species. The new name is based on the types figured by Knowlton (23, p 31, pl. 2, figs. 5, 6, 8 [not. fig 7]) as *Salix perplexa*, and cited by Brooks as the fourth item of her synonymy.

Smith questioned the assignment of Berry's specimens of *Quercus treleasii* to *Sophora spokanensis* Knowlton on the ground that their specific identity is not evident from the published figures and descriptions It is true that at least the petioles in the figures are not clear; but the specimens were cleaned several years ago before the transfer to *Sophora* was made, and the petioles as well as the form and venation were found to be definitely leguminous and identical with the corresponding characters of the specimens previously described as *Sophora spokanensis*.

Occurrence.—Mascall formation, John Day basin; and Sucker Creek, Oreg.

JUGLANDACEAE

Engelhardtia olsoni Brown, n. sp. Fig. 10

This is a small, 3-lobed bract with a conical nutlet at the base The lobes are entire. The venation of each of the lobes consists of a midrib from which arched veinlets connect with intramarginal veins parallel to the midrib for a short distance In the apex of the lobes the secondary veins form a series of loops.

Although this specimen is smaller, it is comparable in other respects to those called *Carpinus grandis* Unger (Chaney, 13, pl 9, fig. 7-9) from Bridge Creek and Crooked River, Oreg Although living species of *Carpinus* only rarely produce fruit bracts with entire margins, it is possible that ancient species may have done so Thus far no leaves of *Carpinus* have been reported from the Latah formation.

Occurrence—Latah formation, 19 miles up Orofino Creek, Idaho. Collected by Boyd H Olson, Orofino, Idaho

EUCOMMIACEAE

Eucommia eocenica (Berry) Brown, n. comb.

Simarubites eocenicus Berry, 5, p 94, pl. 44, figs 15, 16
Carpolithus banisteroides Berry, 5, p 134, pl. 33, figs. 5, 6

Although somewhat smaller and with more attenuate bases than the samaras of *Eucommia ulmoides* Oliver (Fig 4), a tree of central China, the seeds figured by Berry agree very well in all other details. It is not yet clear to the writer what foliage among the abundant remains in the Wilcox group belongs with these seeds, but at least one leaf species is under suspicion.

The fact that *Cercidiphyllum*, a genus now restricted to eastern Asia, has a representative in the Wilcox flora (Brown, 12, pp. 486, 492) makes it less surprising to find *Eucommia* there also.

Occurrence.—Wilcox group, near La Grange and Somerville, Tenn.

Eucommia montana Brown, n. sp. Fig. 3

Samara as in that of *Eucommia ulmoides* Oliver (Fig. 4) of central China, except somewhat wider in proportion to length, which is about half that of *ulmoides*. Tip similarly cleft, margins winged. The pedunculate base is slightly more attenuate. Venation pattern over the seed a reticulate, forking meshwork.

This species is almost identical with that described above as *Eucommia eocenica* from the Wilcox group of Tennessee; but it differs in being a little smaller in size and somewhat wider in the apical half. No leaves that could be definitely assigned to this species were found at this locality.

Occurrence.—One mile west of Grant, Mont., in deposits probably of upper Oligocene age.

LAURACEAE

Sassafras bendirei (Knowlton) Brown, n. comb.

Cinnamomum bendirei Knowlton, 23, p. 59, pl. 10, fig 4

Philadelphus bendirei (Knowlton) Chaney, 13, p. 118, pl. 17, figs. 1, 2 [not other figs.].

These specimens can be matched readily with leaves from the living *Sassafras varifolium* (Salisbury) Kuntze This fossil species may prove to be the same as *Sassafras hesperia* Berry (Brown, 10, p 174, pl 53, figs. 7–10), but the writer is unwilling to synonymize them at the present time.

Occurrence.—Bridge Creek and Crooked River basins, Oreg

Umbellularia eocenica Brown, n. sp. Fig. 18

Leaf oblanceolate to elliptic with acute apex and petiole 1 cm long The venation is characterized by the presence of a pair of thin, lateral primaries arising from the top of the petiole. The secondaries, departing from the midrib at wide angles, form loops with those above. Margin entire

This specimen can be matched closely, though not exactly, with leaves from the California laurel, *Umbellularia californica* Nuttall, which is found on mountain slopes and stream bottoms in the Coast Range and Sierra Nevada region of California, and in southern Oregon.

Occurrence — In shales of the Green River formation, 3 miles north of Watson, Utah.

LEGUMINOSAE

Robinia oklahomensis (Berry) Brown, n. comb.

Diospyros pretexana Chaney and Elias, 14, p. 44, pl 7, figs 6–8. See synonymy.

Salix coalingensis Dorf Chaney and Elias, 14, p. 37, pl 4, figs. 1, 3 [not Fig 6, which is *Sapindus oklahomensis* Berry].

Bumelia oklahomensis Berry, 3, p. 634, pl. 94, fig. 1.

A comparison of the published figures here cited with the specimens themselves supplies an example of the occasional, unfortunate deceptiveness of photographs and drawings, and suggests a warning that if retouching is necessary it be done as faithfully as a satisfactory magnifying glass and a steady hand can make it. Berry's figure of *Bumelia oklahomensis*, for example, has far too many secondary veins. Chaney and Elias have shown Fig. 1 of *Salix coalingensis* and Fig. 8 of *Diospyros pretexana* with no suggestion of intermediary secondaries. Their Fig. 7 of *Diospyros pretexana* shows the petiole directed toward the lower right, whereas in the specimen it is directed toward the lower left, a faint hint of which may be had from the illustration. In all these specimens the petioles are typically leguminous, that is, broad and cross-wrinkled, indicating their glandular nature. In form, venation, and petioles these leaflets can be matched by the leaflets of *Robinia*, particularly *R. pseudacacia* Linnaeus, the black locust of the region east of the Rocky Mountains. The smaller leaflets may also be compared with those of *Amorpha fruticosa* Linnaeus.

Occurrence.—Beaver County, Okla.

SIMARUBACEAE

Ailanthus indiana (MacGinitie) Brown, n. comb.

Apocynum indiana MacGinitie, 27, p. 66, pl. 12, fig. 1.—Smith, 32, p 117, pl. 6, fig 1; pl. 7, fig. 2.
Ailanthus lesquereuxi Cockerell. Arnold, 1, p 95, pl. 8, figs. 3, 4.
Ailanthus (?) *americana* Cockerell. Oliver, Carnegie Inst. Wash. Publ. 455(1): 23. 1934.
Cedrela oregoniana (Lesquereux) Brown [part]. Brown, 10, p. 513.

For a long time the writer has been looking for leaf remains that would confirm the identification of the undoubted seeds of *Ailanthus* found in the Green River formation in Wyoming and Colorado; in the lake beds at Florissant, Colo.; and in the strata on Trout Creek and Sucker Creek, Oreg. It now appears that the specimen reported by MacGinitie from Trout Creek, supplemented by those reported recently by Smith from Sucker Creek, as *Apocynum indiana*, may be the required foliage. In form, venation, and length of petiole they compare favorably with the leaflets of the living Asiatic species, *Ailanthus altissima* (Miller) Swingle The published figures do not show clearly the large basal marginal teeth with glands characteristic of the living species, but Smith's Fig 1 appears to have them.

Seeds called *Ailanthus americana* Cockerell, but no *Ailanthus* leaflets, have been reported from the Green River formation and from Florissant. It is very likely that when and if the leaflets are found they will be sufficiently different to justify the new specific name for the Trout Creek and Sucker Creek material

Occurrence —Trout Creek, Sucker Creek, and Tipton, Oreg

ACERACEAE

Acer knowltoni (Berry) Brown, n. comb. Figs 7, 8

Phanerophlebites knowltoni Berry, 5 p 48, pl. 7, fig 6.
Negundo knowltoni Berry, 5, p 98, pl 21, fig. 7; pl 42, fig. 7.

Additional material collected by the writer in Tennessee demonstrates that the specimen called *Phanerophlebites knowltoni* is a maple samara of the *negundo* type, and undoubtedly belongs with the leaves called *Negundo knowltoni*, these being the only maple seeds and leaves from the same localities and the Wilcox group The samaras have unusually long wings, and narrow heads which are seldom well enough preserved to show the attachment scar. *Acer negundoides* MacGinitie is the well-known relative in the later Tertiary of the western United States

Occurrence.—One mile north of Somerville, Tenn. Wilcox group (Eocene).

Dipteronia insignis (Lesquereux) Brown Fig. 17

Dipteronia insignis (Lesquereux) Brown, 10, p. 181, pl. 59, figs 10–12. See synonymy.

The leaflet figured here, although somewhat fragmentary, has a well-preserved apex and several large rounded, apical teeth, together with the characteristic venation, sufficient to identify the species. The rounded, winged fruits have not yet been reported from the same locality, but they may be looked for with confidence.

Occurrence.—In shales on Bridge Creek, northwest of Mitchell, Oreg.

MALPIGHIACEAE

Tetrapteris simsoni Brown, n. sp. Fig. 9

A 4-winged samara resembling a propeller, one of the wings of which is shorter and narrower than the other three. Venation of wings subparallel to flaring near the apex.

This fruit resembles those of a number of living species of *Tetrapteris*, particularly *T. schiedeana*, found from Mexico to Brazil The species is named for A. G. Simson, U. S Forest Service, who guided me to this locality.

Occurrence.—Four miles west of Mitchell, Oreg, in strata probably in the lower part of the Clarno formation.

OLEACEAE

Fraxinus flexifolia (Lesquereux) Brown Fig 5

Fraxinus flexifolia (Lesquereux) Brown, 8, p 64.

This is the first seed to be reported in confirmation of the previous identification of ash foliage in the Green River formation Although the wing is narrow, it may originally have been wider near the apex.

Occurrence.—Green River formation (middle Eocene), on Piceance Creek, west of Rio Blanco P O, Colo

MENYANTHACEAE

Limnanthemum circularis (Chaney) Brown, n. comb.

Asarum circularis Chaney, 13, p. 115, pl 13, fig. 11.

The resemblances in form and venation between leaves of *Asarum* and *Limnanthemum* are very striking. Nevertheless, there are distinctive differences, so that when the fossil leaf ascribed to *Asarum* by Chaney is subjected to close scrutiny, its assignment to *Asarum* becomes untenable. In *Asarum* there is a midrib flanked by two strong lateral primary veins, from which basal as well as higher branches arise. The base of the blade, together with the midrib and primary veins, make a broad, flaring transition into the petiole. In *Limnanthemum* the leaves are peltate or nearly so with a sharp transition of petiole to blade As should be expected in such leaves, the primary venation is radiate, although one pair of primaries, depending upon the length of the leaf, may appear stronger than the rest. This is the condition in the fossil specimen.

Asarum is a genus of low herbaceous land plants The possibility of such remains getting into the fossil record is perhaps not unlikely, but the probability is remote *Limnanthemum*, on the other hand, is a genus of some 20 species of aquatics widely distributed in temperate and tropical regions and is very likely to get into the fossil record, especially in sediments in quiet waters, such as those in the Bridge Creek and Crooked River basins of Oregon must have been.

Occurrence.—Gray Ranch on Crooked River, Oreg.

OF UNCERTAIN AFFINITY

Banksites lineatus Lesquereux Fig. 11

Banksites lineatus Lesquereux, 26, p. 165, pl. 32, fig. 21.

Banksites lineatulus Cockerell, 16, p. 8, pl. 2, fig. 3.

Originally described from the Florissant lake beds and subsequently from the Green River formation, this species has since been found in strata at

Gray Ranch on Crooked River, Oreg., and in beds probably in the lower part of the Clarno formation, 4 miles west of Mitchell, Oreg. The present occurrences are reported to indicate further relationship between a number of western Tertiary floras.

Occurrence.—Gray Ranch, Crooked River, Oreg. Collected by Charles B. Read.

Porana speirii Lesquereux Fig. 12

Porana speirii Lesquereux. Brown, 9, p. 583, pl. 69, figs 1–3. See synonymy and discussion.—10, p. 185, pl. 61, fig. 14.

Viburnum palmatum Chaney and Sanborn, 15, p. 97, pl. 40, fig. 4 [not fig. 3]

These calyces, although readily identifiable, continue to be mysterious in regard to their botanic affinity. The specimen figured here is the largest the writer has seen, the figure of that described by Chaney and Sanborn as *Viburnum palmatum* being twice natural size. Smaller, but otherwise similar specimens were found in 1938, 4 miles west of Mitchell, Oreg., in beds presumably in the lower part of the Clarno formation.

Occurrence.—Gray Ranch, Crooked River, Oreg. Collected by Charles B. Read.

Porana tenuis Lesquereux Fig. 13

Porana tenuis Lesquereux, 26, p. 173.—Knowlton, 1916, p. 286, pl. 27, figs 4–6.

Philadelphus bendirei (Knowlton) Chaney, 13, p. 118, pl. 17, fig. 5.

Cornus ovalis Lesquereux. Chaney, 13, p. 131, pl. 19, fig. 4.

These specimens, like *Porana speirii* Lesquereux, also remain a mystery as to their correct botanic affinity. Specimens similar to that figured here were also found in 1938 in the Green River formation exposed along Piceance Creek, west of Rio Blanco P. O., Colo.

Occurrence.—One mile west of Grant, Mont., in strata of probable upper Oligocene age.

ADDITIONAL CHANGES

Abies chaneyi Mason (28, p. 149, pl. 4, figs. 1, 7, seeds) = *Cedrela oregoniana* (Lesquereux) Brown.

Acer bolanderi Lesquereux. Smith (31, p. 562, pl. 28, fig. 5; pl. 29, fig. 8; 32, p. 116, pl. 3, fig. 3) = *Acer osmonti* Knowlton. These are small leaves of the silver maple type.

Acer negundoides MacGinitie. Chaney and Elias (14, p. 42, pl. 7, fig. 10) = *Gymnocladus casei* Berry.

Acer osmonti Knowlton. Smith (32, p. 116, pl. 4, fig. 1) = *Platanus dissecta* Lesquereux.

Azolla berry Brown (8, p. 52, pl. 8, fig. 2) = *Azolla berryi* Brown. The omission of the "i" at the time this species was published was deliberate. Although the writer still believes that the principle is sound, it would seem that in this and in *Pinus ball* Brown the application was unfortunate and confusing because of the connotations of the specific names.

Betula ? dayana Knowlton (23, p. 41, pl. 4, fig. 4) = *Ulmus speciosa* Newberry. This leaf has doubly serrate teeth and is evidently a small leaf of the *speciosa* type.

Betula lacustris MacGinitie (27, p. 50, pl. 4, fig. 2) = *Alnus carpinoides* Lesquereux.

Cedrela oregoniana (Lesquereux) Brown. Smith (32, p. 115, pl. 3, fig. 7) = *Castanopsis perplexa* (Knowlton) Brown.

Fagus sp. Hollick (20, p. 401, pl. 30, fig. 4) = *Fagus washoensis* LaMotte.

Fagus sanctieugeniensis Hollick (20, p. 399, pl 30, fig. 3; pl. 31, fig. 3; pl. 32, figs. 2, 3) = *Fagus washoensis* LaMotte. Although *sanctieugeniensis* has priority, the writer urges that an exception to the rules be made here on the ground that the term is lengthy and cumbersome—a coinage contrary to the recommendations in the codes.

Glyptostrobus europaeus Lesquereux. Smith (30, p. 225, pl 1, fig. 14) = *Glyptostrobus oregonensis* Brown.

Oreopanax dissecta (Lesquereux) Smith (32, p 116, pl 1; pl. 2, figs 1, 5) = *Oreopanax precoccinea* (Brooks) Arnold. If Smith's specimens are different from those called *O. precoccinea*, they certainly are not identical with the Florissant species called *Aralia dissecta*.

Phylloteuthis subovata Meek and Hayden (1876, U. S. Geol. and Geog Survey Terr. Rept. **9**: 505, pl. 33, fig. 3) = *Nilssonia gibbsii* (Newberry) Hollick. The illustration of *Phylloteuthis subovata* is in part reconstructed to show an alleged resemblance of the specimen to the "pen" of a squid. The fact that this specimen, from Fox Hills strata (Upper Cretaceous) on the Moreau River, S. Dak., is embedded in a block carrying marine mollusks, was further cause for believing it to be the remains of a marine animal. The form and venation, however, identify it as part of a cycad leaf. (See Brown, 11, p. 245, pl. 49, figs. 5, 6; pl. 52, fig. 6b) This specimen was called to my attention by John B. Reeside, Jr.

Pinus ball Brown (8, p 53, pl. 9, figs. 6–10) = *Pinus balli* Brown. See comment on *Azolla berry* Brown.

Platanus regularis Knowlton. Smith (32, p 115, pl 4, fig 2) = *Platanus dissecta* Lesquereux. Given a large enough suite of Sucker Creek material, this specimen can be duplicated readily as a variant of *P. dissecta*. What does Mrs Smith mean by the paradox: "The specimens are easily separated from *P. dissecta*, with which they have much in common"?

Populus balsamoides Goeppert Elias (18, pl 367, fig. 6) = *Celtis kansana* Chaney and Elias.

Ptelea enervosa Smith (31, p. 560, pl. 29, fig. 6) = *Ptelea miocenica* Berry. The lack of venation in this specimen can be explained by the fact that the Sucker Creek matrix is notoriously poor for preserving fine details. The small size of this fruit does not eliminate it from falling within the limits of variation of *P. miocenica*, if the latter be compared with living species of *Ptelea*.

Ptiloteuthis foliatus Gabb (1869, Paleont. California **2**: 128, pl. 19, fig. 4) = *Sagenopteris elliptica* Fontaine. Originally described from the Shasta group (Cretaceous) of California, by Gabb as the "pen" of a squid, and recently redescribed (Rehn, John W. H., 1939, Acad. Nat. Sci. Philadelphia Notulae Naturae no. 9, pp. 1, 2) as a cockroach wing, this specimen represents a species of fern common in the flora of the Shasta group. This specimen was called to my attention by F. M. Carpenter.

Quercus malheurensis Smith (31, p. 560, pl. 29, fig. 1) = *Acer bendirei* (Lesquereux) Brown. The venation of this leaf, together with the form of its lobes, would, if the leaf were completely reconstructed, show clearly that it is a leaf of the *macrophyllum* type.

Rhus oregonensis Smith (31, p. 561, pl. 29, fig. 9) = *Acer glabroides* Brown. This is a deeply lobed leaf. Instead of having rounded teeth as in *Rhus trilobata* Nuttall, with which it was compared, the teeth are sharp and in the lower left lobe are represented as being double, which they never are in *R. trilobata.*

Salix coalingensis Dorf. Chaney and Elias (14, p. 37, pl. 4, fig. 6) = *Sapindus oklahomensis* Berry.

Salix perplexa Knowlton (23, p. 31, pl. 2, fig. 7) = *Pterocarya mixta* (Knowlton) Brown Fig. 7 depicts an entire-margined specimen, which, in fact, has serrate teeth.

Sciadopitys americana Smith (30, p. 225, pl. 1, fig. 1) = *Pinus* sp. This is a needle of a species of pine, of which three are described from the same formation and region.

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ANTHROPOLOGY.—*The finding of an Indian ossuary on the York River in Virginia.*[1] T. D. Stewart, U. S. National Museum.

As recently as 1935, when Davidson wrote his paper on the burial customs in the Delmarva Peninsula, there were no published descriptions of Indian burials from the Algonkian territory south of Chesapeake Bay. Since that time, however, detailed records have been made for at least 17 ossuaries—the prevailing mode of burial—on the tidewater section of the Potomac River (Graham, 1935; Ferguson, 1937a and 1937b; Stewart and Wedel, 1937; Stewart, 1939 and 1940a). The present report adds to this record the only carefully investigated case from the tidewater region south of the Potomac.

HISTORY OF THE REGION

The earliest description of the York River is that of Capt. John Smith in 1608:

> This Riuer of *Pamaunke* [York] is not past twelue mile from that we dwell on [James], his course northwest and westerly as the other. *Weraocomoco* is vpon salt water in bredth two myles, and so [the river] keepeth his course without any tarrying some twenty miles; where at the parting of the fresh water and the salt, it diuideth it selfe into two partes, the one part . . . [Pamunkey], as broad as *Thames*, and nauigable with a Boate threescore or fourescore miles. . .
>
> The other branch [Mattaponi] a little lesse in breadth, yet extendeth not neare so farre. . . . (Arber, 1884, pp. 20–21)

Repeating essentially the same description in 1612, Smith adds:

> Where this river is divided, the Country is called *Pamavnke* [West Point], and nourisheth neere 300 able men. About 25 miles lower on the North side of this river is *Werawocomoco*, where their great King inhabited when

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[1] Published by permission of the Secretary of the Smithsonian Institution. Received March 1, 1940.

Captain *Smith* was deliuered him prisoner; yet there are not past 40 able men. (Arber, 1884, p. 51.)

In addition, Smith's map of 1612 shows three small Indian villages on the north side of the river between the fork and Werawocomoco: Pasaughtacock, Poruptanck, and Mattacock. The name of the second village in the course of time may have been extended to the creek that forms part of the boundary between King and Queen and Gloucester Counties and now known as Poropotank Creek.

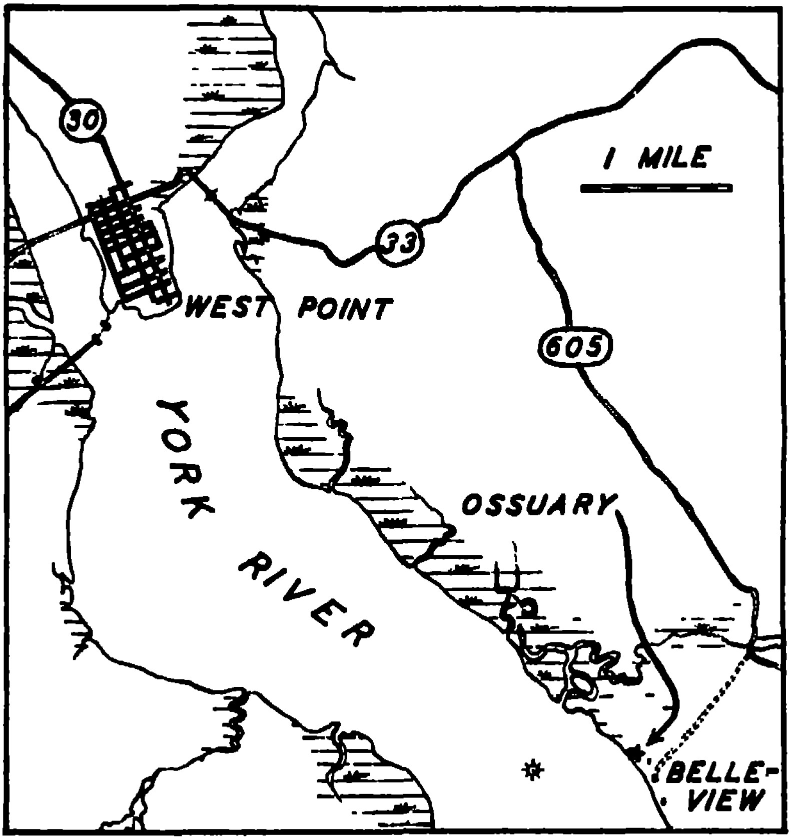

FIG. 1.—Map showing the location of the ossuary in relation to the York River and the highway system passing through the town of West Point. (Based on the Geological Survey maps of Virginia New Kent, Urbana, Toano, and Williamsburg quadrangles, 1906–1919.)

Beginning about 1642 (Nugent, 1934, p. 131 et seq), large tracts of land on the north side of the York River (then known as the Charles) were patented. The boundaries of these patents are usually indefinite unless physiographical landmarks are mentioned. In this connection it is noteworthy that "Poropotanck" Creek figures prominently in the land records.

These are the essential historical data pertaining to the site of the

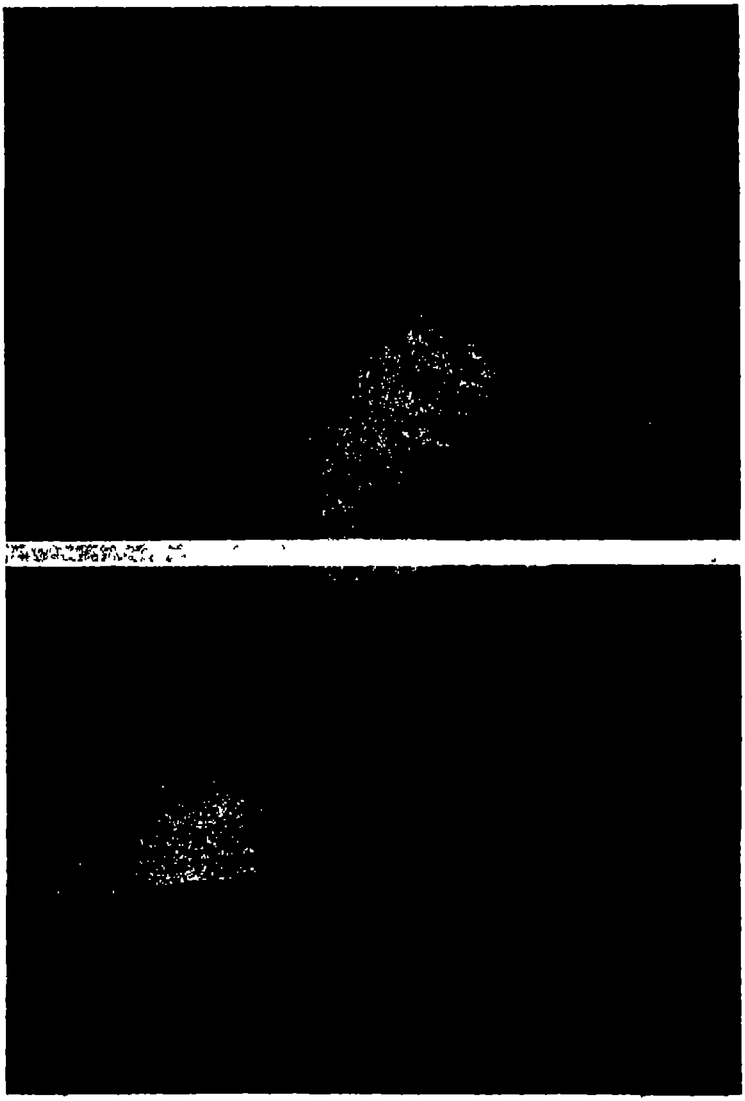

Fig. 2—Appearance of the north shore of the York River in the vicinity of the ossuary. Looking north. Human bones from the ossuary may be seen on the beach and protruding from the bank.

ossuary, which, it will be seen from the accompanying map (Fig. 1) is located on the north bank of the river between 4 and 5 miles below the fork, or where the present town of West Point is situated.

DESCRIPTION OF THE SITE

The circumstances of the find are as follows: Several years ago following a spring flood, B. R. Anderson, the present owner of Belleview farm, saw for the first time some bones exposed along the river bank about 850 feet upriver from his house. He reburied them. From time to time since then, however, bones have been seen along the beach, and finally in the fall of 1939 L. R. Treat, of West Point, obtained some and brought them to the attention of Dr. Malcolm H. Harris, also of West Point. Being familiar with the history of the colonial period, Dr. Harris at once sensed the significance of this find and imparted the information to the Smithsonian Institution, suggesting at the same time a scientific examination of the site. As a result, I was detailed from October 26 to 28, 1939, inclusive, to make this investigation.

At the time of my visit, bones could be seen protruding from the river bank (Fig. 2) for a distance of 10 feet. Also, loose bones were seen along the beach, both nearby and at a considerable distance. When the sand was dug away from the base of the bank it appeared that the waves had undercut the bone layer and caused blocks of it to drop down, as is typical of this form of erosion. The soil in this area apparently contains much clay, for the vertical surface of the bank had been baked by the sun so that it resisted the point of a pick delivered with considerable force. Under these circumstances, and since the protruding bones were badly damaged, there was nothing to do but remove the outer layer and thus reach the soft soil. When this was done it became possible to collect whole bones and to observe their relationship.

It was determined that the bone layer (8 inches to 1 foot thick) extended into the bank only about 4 feet in the middle and less at either end. It seems likely, therefore, that the original shape of the pit was ovoid—perhaps 8 by 10 feet. If this is true, then about half of the ossuary had been washed away before it could be examined.

It was observed, also, that the remains found around the periphery of the pit—that is, farthest within the bank—were at a higher level (3 feet from the top); in other words, the sides of the pit were not vertical, but sloping, as is the usual finding. Moreover, the limits of the pit were easily distinguishable, because the fill was softer and of a darker color than the undisturbed soil. The fill surrounding the human bones yielded many large oyster shells, six potsherds, parts of a dog's skull, a turkey humerus, and the calcaneus of a deer.

The human bones within the ossuary were distributed in definite bundles and frequently with related parts in positions indicating that they were still articulated when interred. At the point on the periphery of the pit occurring deepest within the bank a quantity of charred bone fragments was found scattered about, but seemingly associated with a well-preserved large male skull. It was obvious, however, that these bones had been burned prior to burial.

As the ossuary was explored a selection of bones was made for further study, consisting of whole skulls and long bones and such other parts as past study (Steward and Wedel, 1937) has shown to be of most value in this type of investigation. The examination of this material is reported below.

CULTURAL MATERIAL

Potsherds constitute the only cultural material from the ossuary that requires further description. The six sherds recovered (U.S.N.M. no. 380715) suggest two types of ware: (1) A thick (7–9 mm) coarsely shell-tempered variety with irregular fracture lines; and (2) a thin (3–5 mm) lightly shell-tempered variety with straight fracture lines suggesting a coiled structure. Fairly large vessels are suggested by the curvature of the bigger sherds especially those of the coarser variety. Color ranges from black through variable gray to orange-buff. Leaching of the shell has left the surfaces pitted, particularly in the coarser variety. Otherwise the surfaces show mostly the striations due to a smoothing implement with an occasional faint suggestion of net impression or a cord-wrapped paddle.

Only one rim sherd was recovered; it belongs to the thin variety of ware and has a crudely everted lip. The surface of this sherd has flaked off somewhat but still shows a diagonal striation that may be an attempt at decoration.

During the time spent at this site I took the opportunity to examine the neighboring field and river bank. Local residents asserted that until recent years the shore at this point had been a part of the swamp that now ends a short distance upriver (see figure). The field here is quite flat, and although it had not been plowed recently, except back about 100 feet from the river, it was possible to see some of the surface. Pottery was not in evidence; indeed, I found only one artifact, a small triangular quartz point.

Downriver from the old colonial farmhouse, the fields, unlike those above, are full of oyster shells. Along this section of the river bank it was possible frequently to find small potsherds just below the sod. A small collection from this place (U.S.N.M. no. 380716) differs from the ossuary sample chiefly in including thick grit-tempered sherds with exterior surfaces probably net marked. Because of the smallness of the samples, it is impossible to say whether these differences are significant. In general, however, these wares are typical of the area.

SKELETAL MATERIAL

Number.—Since part of this ossuary had been washed away, we can never know the accurate number of individuals buried here. Even an approximation, however, is of value for comparative purposes. For this reason the skeletal parts recovered (U.S.N.M. nos. 379062–379-088) are listed in Table 1. According to this listing more skulls are represented than other skeletal parts. In round numbers the maximum is 25. Assuming that half of the ossuary was washed away, the number originally buried here was approximately 50. As compared with the Potomac ossuaries of which only 5 out of 17 contained 50 or fewer bodies, this one from the York River thus ranks with the minority as small.

Sex.—Exact determination of sex is difficult in fragmentary material and has not been attempted here. Both sexes, however, are represented and not disproportionately.

Age.—Most of the skeletal remains are those of adults, only 7 subadults being noted. As judged by the teeth of the lower jaw, these 7 subadults fall into the following age periods: 2- 6 years, 2; 6–12 years, 3; over 12 years, 2.

Physical type.—Of the recovered skulls, 8 (adults: 4 males, 4 females) were sufficiently complete to permit measurement. These have cranial indices ranging from low dolichocrany to low brachycrany 70.7, 72.0, 72.7, 74.0, 74.1, 75.3, 78.3, 81.8 (asymmetrical). The mean height indices of these skulls, with two exceptions (81.9 each), indicate high vaults (83.9–88.5). These figures are typical of the general Algonkian range (Hrdlička, 1927). Further skull measurements will not be given here because a detailed study of the accumulating skeletal remains from this area is planned for the future.

Table 1.—Number of Bones Recovered from the Ossuary

Bone	Right		Left
Temporal	23		19
Lower jaw[1] . .		20	
Humerus (distal end).	17		12
Femur (proximal end) .	16		18

[1] With symphysis, possibly 6 others represented

The remaining skeletal parts present among other things two anomalies, the frequency of which, even in such a small sample, suggests relationship with other Algonkian groups: (1) The external auditory meatus is generally free from exostoses, only traces being noted in 7.1 per cent of the ears (42). This compares with 10 per cent for the two Anacostia ossuaries (Stewart and Wedel, 1937). (2) Of 26 humeri about 54 per cent show septal apertures. Although this is somewhat higher than the 43.2 per cent recorded for the Anacostia ossuaries, it is nevertheless fairly typical of the Northeastern Indians (Hrdlička, 1932).

Stature in such a small sample is perhaps best gauged by the maximum encountered. Thus, the longest humerus is 36.3 cm and the longest femur 51.5 cm. According to Manouvrier's tables (Hrdlička, 1939) these lengths correspond to a statute of nearly 6 feet.

Pathology.—Pathological bones include 5 right and 8 left tibia with lesions such as are generally attributed to syphilis. One frontal bone shows scars perhaps caused by the same disease.

As usual among the Indian remains from this region the teeth are frequently decayed. Caries appear to be chiefly of the developmental type; that is, beginning in the fissures on the occlusal surface.

Burnt bones.—This lot of fragments—all that were found in the ossuary—includes parts of most of the major bones of the body and apparently of one individual. The lower jaw indicates that this individual was an adult. Unfortunately, however, the sex characters are not positive; it was either a small male or a female.

DISCUSSION

The conclusion reached in this study is that the York River ossuary has the same general features as those found along the Potomac River. In view of the proximity of the two areas, and their history, this is to be expected. Among the features possessed in common by the majority of these ossuaries are the following:

1. Association with a recognizable habitation site.
2. Rounded pit, 3–4 feet deep, with sloping sides.
3. Bones arranged in bundles and indicating at least a partial articulation.
4. Poverty of accompanying cultural remains.
5. Presence in the pit of burnt human bones
6. Ages and ratio of sexes reflecting normal death rate.
7. Physical type of the Northeastern Indians.
8. Presence of dental caries and (probably) syphilis.

The finding of the burnt bones in the York River ossuary is of interest in view of the following statement by Stewart and Wedel (1937, pp. 218–219): "The finding of calcined bone in the second pit at Anacostia is something new for this area and cannot be clearly explained."

Of the ossuaries investigated since 1937 by Mrs. Ferguson, the late Judge Graham, and me, almost all have contained burnt bones. Mrs. Ferguson[2] informs me that each of her 5 major ossuaries contained deposits of burnt bones, varying in number up to 7 and estimated to have included at least 38 individuals. In no case did it appear that the firing had occurred in the pit, for adjacent bones were normal in appearance. Moreover, whole skulls were sometimes found to contain fragments of charred bone.

The records left by the late Judge Graham are not so complete but indicate essentially the same thing. Of the 4 ossuaries that he excavated, 3 contained deposits of burnt bone, ranging up to 4 in number and possibly including 10 individuals. In only one instance do I find an opinion expressed in his notes regarding the place of burning. This is to the effect that they could not have been burned *in situ*. In two cases Judge Graham noted that the burnt bones belonged to infants.

Following up Judge Graham's work at Potomac, I succeeded in locating and partly excavating a fifth ossuary (Stewart, 1940a). Among the first human bones encountered on the periphery of this pit was a mass of burnt fragments representing remains of more than one individual.[3] The position of this deposit—on the sloping side of the pit—and the close proximity of normal bones, make it seem improbable that the firing occurred in the pit.

In addition, both Mrs. Ferguson and Judge Graham, but especially the former, have found individual secondary burials in which the bones were burned.

The uniformity of these findings suggests that the burning of one or more individuals was commonly a part of the burial ceremony in this area.[4] Whether this ceremony was simply a cremation or a sacrifice naturally can not be ascertained from the bones. However, Mrs. Ferguson has called my attention to the following statement in Henry Spelman's *Relation of Virginea* (Arber, 1884, pp. cv–cvi):

> In y^e Patomecks cuntry they haue an other god whom they call Quioquascacke, and unto ther Images they offer Beades and Copper if at any time they want Rayne or haue to much, and though they obserue no day to worshipe ther god: but uppon necessitye, yet onc[e] in the yeare, ther preests w*hi*ch are thor coniurers with y^e [*people*] men, weomen, and children doe goe into the woods, wher ther preests makes a great cirkell of fier in y^e

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[2] Personal communication. February 26, 1940.

[3] Material not yet studied.

[4] In 1936 I examined the remains of an ossuary exposed in a gravel pit near Cambridge, Md. (Dorchester County). Here, too, a charred adult bone was noted.

> which after many obseruanses in ther coniurations they make offer of 2 or 3 children to be giuen to ther god if he will apeare unto them and shew his mind whome he [*will haue*] desier. Vppon which offringe they heare a noyse out of y^e Cirkel Nominatinge such as he will haue, whome presently they take bindinge them hand and footte and cast them into y^e circle of the fier, for be it the Kinges sonne he must be giuen if onc[e] named by ther god, After y^e bodies which are offered are consumed in the fier and ther cerimonces performed the men depart merily, the weomen weaping.

It is possible, therefore, even though burned children's bones are uncommon in the ossuaries, that all such remains represent some religious rite other than a burial ceremony.

Finally, a word may be said about the age of these ossuaries. Of the 17 ossuaries to which reference has been made, 6 contained European articles—glass, copper, iron, or silver—in considerable abundance; the remainder had only native artifacts—shell beads, clay pipes, etc. This finding represents, I believe, a clear distinction in time: before and after trade goods became plentiful, or roughly before and after 1608.[5] Since this dividing date is more than 100 years after the discovery of America, it seems unlikely that few or any of the ossuaries lacking European objects are pre-Columbian in age. This view is supported by the presence of syphilitic bones in all of the ossuaries thus far examined. I have summarized elsewhere (Stewart, 1940b) the evidence for believing that this disease appeared in North America in relatively recent, possibly even post-Columbian, times.

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[5] Probably 10–20 years later in some places.

JOURNAL
OF THE
WASHINGTON ACADEMY OF SCIENCES
VOL 30 SEPTEMBER 15, 1940 No 9

PALEONTOLOGY —*Fossil pearls from the Colorado group of western Kansas*[1]

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Although pearls taken from living mollusks are familiar to everyone as lustrous ornaments, often of great beauty, fossil pearls are seldom seen As a rule they are not spectacular, for, with few exceptions, they have lost their original luster, and, unless still embedded in or associated with an identifiable shell they have also lost some of their scientific significance Whether they are as rare as the 45 or 50 records would indicate is not definitely certain, because it is altogether likely that by many collectors they may hitherto have been unsought or may have been mistaken for other objects that simulate them, such as ordinary rounded pebbles, concretions formed by inorganic processes, cave "pearls," oolites, pisolites, otoliths, fish teeth like those of *Sphaerodus*, algal nodules, and even seeds or fruits of plants

The literature about ornamental pearls runs the whole gamut of fact and fancy, as one may learn from the extensive bibliography in *The book of the pearl* by Kunz and Stevenson (18) Of fossil pearls however, the literature embraces only about 30 titles These are cited in part in the recent papers by Russell (24), Berry (2), Zilch (33), and Frenguelli (9) All these students have also published tables showing the distribution of fossil pearls known to the date of publication Zilch (33), in particular, has reviewed every occurrence known to him and has made two changes that should be noted by those who compare these tables, namely, *Perna oblonga* Seeley is *P seeleyi* Zilch, and *Perna sandbergeri*, cited erroneously at first by Zilch (32), is *P oblonga* Röhmer and Büchner (33) In the latest table, that by Frenguelli, *Perna oblonga* should read *P seeleyi* *Perna sandbergeri* should read *P oblonga* and the occurrence 5 should be changed from Pliocene to Oligocene, *Nautilus* sp should read *Pleuronautilus pseudoplanilaterus*, also the occurrence cited as 30 in the Eocene should be changed to Oligocene All the tables cited have omitted J Marwick's record of pearls from *Melina zealandica* in the Pliocene of New Zealand (20) Further

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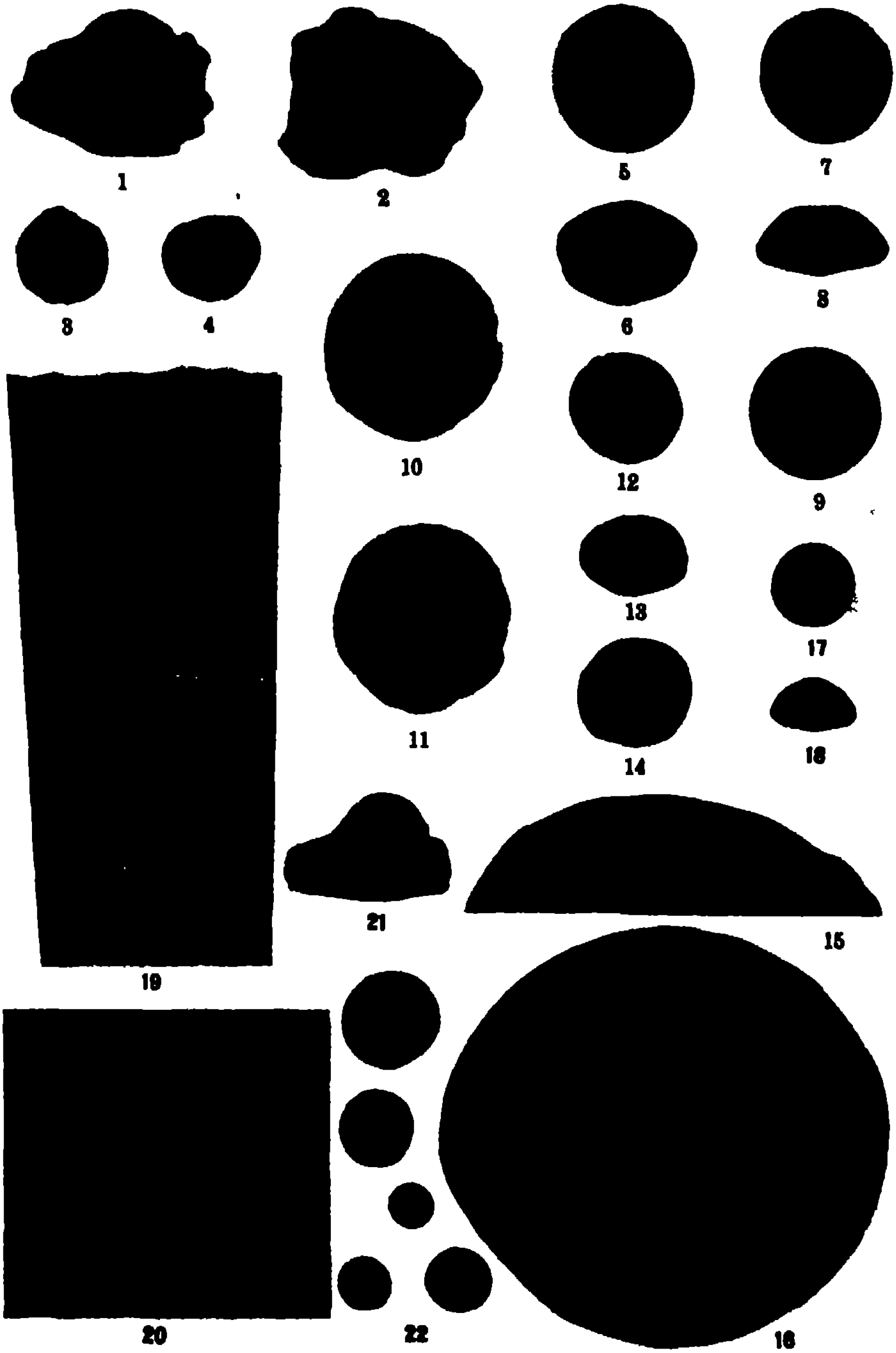
[1] Published by permission of the Director, Geological Survey U S Department of the Interior Received April 29, 1940



Figs. 1–22.—(See opposite page for explanation.)

records not appearing in previous tables are those by Dorn (7) and Kutassy (19). Here too may be added a note that Dr. S. F. Blake, of the U. S. Bureau of Plant Industry, has found subsequent to Berry's record (2) a large blister pearl also in a *Panopea americana* shell from the Miocene at Jones Wharf, Md. Blake's pearl is slightly larger than Berry's but has the same outline and occurs in exactly the same position near the hinge line. The exterior of the shell does not now show evidence of having been perforated, but irregularities in the amount and contour of shell substance indicate that some pathologic condition prevailed. The instances to be recorded here are worthy of being added to the list of occurrences of fossil pearls, because the pearls are not only firm, unusually large, well formed, and characteristic, but the records are from strata that, although carrying marine faunas chiefly of Foraminifera and Mollusca, have not yet been cited as yielding pearls.

Five of the new specimens (Figs. 1, 3, 4, 5, 12) were collected by George F. Sternberg, of the Fort Hays Kansas State College, at Hays, Kans., from scattered outcrops of the Niobrara formation (Upper Cretaceous) along the Smoky Hill River valley west and southwest of Hays and extending into Gove and Logan Counties toward the head of that valley. Several of these specimens were taken from remains of *Inoceramus*, but a few were found free. Two specimens (Figs. 7, 10) were collected by A. H. Schutte, of Ellis, Kans., from the Benton shale, which underlies the Niobrara limestone, along a tributary of Smoky Hill River, 16 miles south of Hays. These 7 specimens, together with 36 more collected by a friend of Mr. Sternberg from the Benton shale 18 miles east of Hays, were sent to the writer by Mr. Sternberg for confirmation of the tentative identification as pearls.

All the Niobrara pearls are now lusterless and are dull, yellowish gray to dark gray in color. Four are of discoid or oblate spheroid form, the largest (Figs. 5, 6) having a long diameter of 2 cm and a

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Figs 1–6, 12–16, 19, 20.—Fossil pearls from the Niobrara limestone. Figs. 1, 2.—Different views showing same pearl partially embedded in the prismatic layer of an *Inoceramus* shell. Fig. 6.—Side view of 5. Fig. 13.—Side view of 12, showing equatorial line where cut was made for section 14 Fig. 15—Section at right angles to the long diameter showing irregularities in deposition of the laminae. The dark spots are limonite. ×4. Fig. 16.—Same as 14, ×4. Fig. 19.—A sector of 14, showing radial prismatic calcite, ×40. Fig. 20.—Polygonal surface pattern of 5. ×16. Figs. 7–11, 21, 22.—Fossil pearls from the Benton shale. Figs. 7–9.—Top, side, and bottom views of a hemispheric pearl. Figs. 10, 11.—Top and bottom views of a baroque. Figs. 17, 18.—Bottom and side views of a modern hemispheric pearl from the common clam, *Venus mercenaria*, for comparison with 8 and 9. Fig. 21.—A hemispheric pearl resting on the prismatic layer of an *Inoceramus* shell. Fig. 22.—Group of spherical pearls. All figures natural size except as indicated.

short diameter of 1.3 cm. The smaller specimens (Figs. 3, 4) are somewhat irregular and appear to have suffered slight fracturing and distortion by mechanical causes probably subsequent to entombment in the Niobrara sediments. Portions of the smooth outer laminae of some of the pearls have been spalled off. This outer surface, where well preserved, is seen under a 14-power hand lens to be a pattern of minute, closely packed polygons (Fig. 20), each convexly domed outward. These polygons represent the slightly eroded ends of radial prisms. The smooth surface of the prismatic layer exposed on the interior of an *Inoceramus* shell displays the same pattern.

Figs. 1 and 2 illustrate an almost spherical specimen, similar in color and texture to the others but partially embedded in a piece of the prismatic portion of the host *Inoceramus* shell. Nothing apparently now intervenes between the pearl and the shell, and none of the nacre of the shell remains, but whether this means that the growth of the prismatic layer was gradually enveloping the pearl is a matter of conjecture, though parallels to this condition are not rare in modern mollusks. The writer has been unwilling to risk destruction of the pearl by attempting to detach it from the shell merely to satisfy curiosity on this point.

One specimen (Figs. 12–16) was cut in half through the equator by using a thin copper wire and carborundum powder. The sections reveal numerous light and dark, concentric, closely-spaced rings or laminae around a small, indefinite, rusty-stained nucleus. Darker parts of some rings are transitional circumferentially into lighter portions of the same rings. Under the microscope the rings show some slight variations in smoothness of curvature and in width both in themselves and as compared with one another (Fig. 19). They are composed for the most part of large, radially disposed crystals of calcite. No conchiolin appears to be present now. The section does not display a black cross under crossed nicols, and in this respect is similar to the prismatic portion of Russell's second pearl (24, p. 422). Narrow radial zones of distortion along which secondary calcite has been sporadically deposited may be seen in the right half of Fig. 16. Fig. 15 is a section cut through the short diameter at right angles to the long diameter. It differs from the previous section chiefly in showing greater irregularity in deposition of the concentric laminae. The dark spots are flecks of secondary limonite, probably after pyrite. These sections compare well with those reproduced by Russell (24, figs. 4–7), Newton (22, pl. 5, figs. 3–6), Kunz and Stevenson (18, plate facing p. 53), and others.

It has already been intimated that the Niobrara pearls were produced by a species of *Inoceramus*. The large size of the pearls predicates a large mollusk as host, and this suggests that *Inoceramus* [*Haploscapha*] *grandis* may have been the species, but certainty concerning this can not be established until a pearl is found in a shell or portion of shell which can be specifically identified.

The Benton pearls are of various forms: spherical (Fig. 22), oblate, hemispheric (Figs. 7, 21), oblong, and irregular (Fig. 10). These pearls are, in general, darker in color than the Niobrara specimens. The largest is an irregularly rounded baroque, 3.5 cm in diameter, with a corrugated surface. The surfaces of these pearls display the distinctive polygonal pattern noted in the Niobrara pearls (Fig. 20), and there is no doubt that the Benton pearls were also produced by one or several large species of *Inoceramus*, for a number of specimens are still attached to portions of shell showing the characteristic hinge line.

Figs. 7, 8, and 9 represent a specimen, hemispherical in general form, its top (Fig. 7) slightly flattened with a depression in the center. The under side (Fig. 9) displays a series of concentric growth rings, but at the outer edge can be seen the now ragged margin of the smooth coating of the upper surface lapping over on the under surface. This condition can be matched by the structures observable on the under sides of modern hemispheric pearls (Figs. 17, 18) from the common clam, *Venus mercenaria*. The dimple on the top side also finds its counterpart in some modern pearls. The development of hemispheric pearls is explained by Kunz and Stevenson (18, p. 57) as follows:

> When a growing pearl is very near to the nacreous lining of the shell, the pressure between the two hard substances results in a rupture of the pearl-forming sac and the epithelial layer of the shell, and the pearl comes in actual contact with the nacre. The pearl gradually becomes attached to the shell, and the under portion is prevented from growing further; the upper or exposed surface receives other layers, resulting in the formation of a *bouton*.

Figs. 10 and 11 represent the top and under sides of an irregular, flattened pearl. In structure and appearance this specimen seems unrelated to those already described. On the under side, however, eccentric lines of growth around a distorted nucleus can be detected, and the smooth patch on the upper side under a 14-power hand lens displays the same polygonal pattern as the surface of the other pearls. Because this pearl is thin, flat, and irregularly but smoothly lobed or corrugated it would seem to compare best with a modern baroque or perhaps a blister pearl. The latter are said to be formed when foreign

TABLE 1.—DISTRIBUTION OF FOSSIL PEARLS. (Numbers refer to citations. B, N = Benton and Niobrara pearls described in this paper.)

Host shell	Triassic	Jurassic	Cretaceous	Eocene	Oligocene	Miocene	Pliocene	Pleistocene
Ceratites compressus	16							
Exogyra texana			1, 24					
Gryphaea dilatata		14, 21						
Hippurites sp.			17					
Inoceramus expansus			22					
goldfussianus			10					
labiatus			22					
sagensis			27					
subundatus			24					
spp.			14, 21, 22, 31, B, N					
Lima scabra							14	
Megalodus amplus	19							
Melina zealandica							20	
Mytilus edulis								14
trigonus?						9		
Ostrea cymbula				6				
eduliformis		7						
edulis							14	
tenera				14				
ventilabrum					25			
sp.				6, 29, 30				
Panopea americana						2		
Perna heberti					33			
maxillata						12		
oblonga						32, 33		
sandbergeri					32, 33			
seeleyi			22, 26, 33					
Pinna affinis?				13, 24				
Pleuronautilus pseudoplanilaterus	15							
Pteria sp.				24				
Volsella modiolus								23
?					3	4, 33		

bodies such as sand grains become lodged between the mantle and the shell, or when a mollusk attempts to repair injuries to the shell.

Many of the fossil pearls so far reported were derived from species of *Inoceramus* of the Cretaceous period, a circumstance that would seem to label these species as the pearl "oysters" par excellence of that time, 100,000,000 years ago. The only other Cretaceous records are from species of *Perna, Exogyra,* and *Hippurites.*

No definite pearls have been recorded from the Paleozoic, but J. Smith[2] reports from the Upper Silurian:

> *Pearls* (?).—In the shale at Sedgley, Woolhope, Dormington, Lincoln Hill, Benthall Edge, and Gleendon Hill, a number of minute spheroidal bodies occurred. Some are silvery white, some yellowish, and others of a dark-brown color when viewed by reflected light. All of them have a peculiar pearly

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[2] SMITH, J. *Notes on a collection of bivalved Entomostraca and other Microzoa from the Upper Silurian strata of the Shropshire District.* Geol. Mag. n. ser., dec. 2, 3: 72. 1881.

> lustre. One that had been split through the middle shows a concentric laminated structure. On washing some of the rotten limestone from the Much-Wenlock quarries, I found these pearls (?) very abundant

All the Mesozoic and Cenozoic periods are represented by examples. In Table 1 showing the distribution of fossil pearls as now known the numbers refer to citations which, in several instances, include more than one occurrence.

It will be observed that all the mollusks in the list, with the exception of *Ceratites* and *Pleuronautilus*, are bivalves (pelecypods). Theoretically, however, any mollusk that builds a shell by means of a mantle that, besides depositing the horny periostracum or outer layer and the calcareous prismatic middle layer, also secretes the calcareous nacre or mother-of-pearl of the inner layer, should be able to produce pearls. Today most commercial pearls come from species of bivalves: pearl "oyster" (variously assigned to *Pinctada*, *Meleagrina*, or *Margaritifera*), sea mussel (*Mytilus*), fresh water mussels (*Unio*, *Elliptio*, *Anodonta*, *Dipsas*); but species of many other genera also yield pearls. Among univalves (gastropods or snails) the following are known to produce pearls: common conch (*Strombus gigas*), abalone (*Haliotis*), and chank (*Turbinella*). The pearly nautilus (*Nautilus pompilius*), a cephalopod, sometimes produces pearls of a yellowish color.

The inevitable question always asked concerning pearls is, How do they originate? Considerable investigation has been conducted in attempts to penetrate the mollusks' secret, with the result that some specific conclusions now seem sound. To understand the causes and methods of pearl formation it is necessary first to consider what the end product, a pearl, is. The usual spherical pearl is a calcareous concretion composed of a nucleus and many more or less concentric layers or laminae of minutely platy aragonite (mother-of-pearl, nacre, $CaCO_3$), separated by thin layers of organic conchiolin ($C_{30}H_{48}N_9O_{11}$). Spherical pearls, however, are only one of the many forms pearls may take. These forms depend largely on the position of the pearls in the mollusk, whether attached to the shell or free in the mantle or muscle. Pearls originally free may eventually be buried by enveloping shell growth. The free pearl is formed within a sac lined by epithelium, the layer of the mantle that secretes the different parts of the molluscan shell. The methods by which epithelial sacs are formed and how they enclose instigating nuclei are discussed and illustrated by Dakin (5, pp. 91–116), and Boutan (4, p. 294).

Inasmuch as different areas of the mantle surface deposit different parts of the molluscan shell, how does it happen that epithelium derived from one spot in the epithelium of the mantle and now lining an isolated pearl sac can produce a pearl that duplicates the composition and structure of all the substances of the host shell? Dakin (5, pp. 24, 25) answers:

> If a mollusc shell is broken (or a piece of the shell removed) some distance away from the edge, a most extraordinary thing happens, which is of the greatest importance in regard to theories of pearl formation. The shell is repaired, but the repair substance is not, as was once thought, only nacre The mantle cells, which normally would be secreting nacre, now secrete at the area of breakage, first periostracum, then prismatic layer, and finally mother-of-pearl. Thus, although certain parts of the mantle surface secrete *normally* certain definite parts of the shell, the cells which secrete the nacre are capable of secreting all the other layers if necessary.

It follows that the segregated epithelium surrounding the nucleus of a pearl may deposit layers of both calcareous and organic substances. Part of the epithelium may even be secreting aragonite, while simultaneously another part is depositing conchiolin. Next to an inciting nucleus, therefore, epithelial cells play the essential role in the process of pearl formation.

The importance of the epithelium was demonstrated by the experiments of Alverdes and also by the practical experience of Mikimoto with culture pearls. In the modern culture pearl industry as practiced by the Japanese, a pellet of nacre is first placed on the epithelium of the mantle of one mollusk. After enclosing the pellet and suturing, this part is excised and transplanted to the mantle of another mollusk, which is then returned to the water. Upon removal, after a period of seven years, about 60 percent of the mollusks yield pearls. Of these, 5 percent are said to be marketable (8, p. 423).

Although the age-long empirical methods of the Chinese in artificially stimulating mollusks to produce pearly growths by introducing foreign objects, such as small images of Buddha, between the shell and mantle, suggest that some natural pearls may originate from the accidental intrusion of grains of sand, particles of mud, fragments of shell, etc., nevertheless evidence is accumulating to the effect that many, and perhaps most, natural pearls have their inception from particles originating within the epithelium of the mantle, or from parasitic larvae of worms that become encysted within the epithelium. In the latter case, if the mollusk is not devoured by that one of its predators which is the next required host in the predestined life cycle of the worm, a death sentence automatically passes upon the larva, and it is forthwith entombed in a pearly mausoleum. To quote Kunz and Stevenson (18, p. 45): "Some truth exists in the statement that the most beautiful pearl is only the brilliant sarcophagus of a worm." Some of the Benton and Niobrara pearls, therefore, may be mute testimonials to the Cretaceous existence of a cestode or trematode of which we may never know anything more. Some may also indicate shell-boring predators.

The writer is indebted to many of his colleagues for help in this study, but particularly to Dr. W. F. Foshag, curator of mineralogy at the U. S. National Museum. Specimens (Figs. 1, 5, 7, 14, 21, 22) are deposited in the U. S. National Museum.

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PALEONTOLOGY.—*Two new corals from the Avenal formation (Eocene) of California.*[1] John W. Wells, Ohio State University. (Communicated by John B. Reeside, Jr.)

The two new species of solitary corals described below were collected by Dr. Ralph Stewart, of the United States Geological Survey, who kindly turned them over to the writer for description. They are particularly interesting because of their close relationships with Eocene corals of the Gulf Coastal Plain and the Antillean regions.

Family CALAMOPHYLLIIDAE

Genus Antilloseris Vaughan, 1905

Antilloseris? vaughani, n. sp. Figs. 1, 2

Corallum solitary, turbinate, flaring rapidly from a subcylindrical base. Calice circular, shallow. Corallite wall synapticulothecal, thickened to a septotheca basally, irregularly perforate near calicular margin, nonepithecate, costate. Costae corresponding to all septa, equal, crispate or finely granulose laterally and on margins. Septa very numerous, in six systems, probably with six complete cycles and part of the seventh (about 250 septa in holotype). Septa thin, mostly imperforate and laminar, except those of the first two cycles which are relatively thick and laterally and basally subspinose, with inner ends free and thickened. Synapticulae rare except in mural region. Endotheca and exotheca absent. Columella wholly absent.

Dimensions of holotype.—Diameter of calice, 20 mm; height of corallum, 7 mm; diameter of corallum 7 mm below calice, 7 mm.

Holotype.—U.S.N M no. 498697.

Type locality.—U. S. Geological Survey locality 14482; California, Kettleman Plain quadrangle, T. 23 S., R. 17 E., sec. 35, 400 feet south of north boundary and 2,110 feet east of west boundary of section, near Little Tar Spring. Avenal formation, near Domengine horizon.

Remarks.—The agaricid nature of this coral is shown by the thin, slightly and irregularly perforated septa and by the synapticulothecal wall. The absence of any dissepiments, even basally, and of any trace of columella further indicates a generic assignment in or very close to *Antilloseris*, a genus confined to the Eocene and heretofore found only in the Antillean region. In all the described species[2] of *Antilloseris*, however, the corallum is more or less

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[1] Received April 10, 1940.

[2] Duncan, P. M. Quart. Journ Geol. Soc. London 29: 558–560, pls. 21, 22. 1873. Vaughan, T. W. Bull. Mus. Comp. Zool. 34: 245–246, pl. 40. 1899. In both these papers the species included by Vaughan in *Antilloseris* in 1905 are described as *Turbinoseris*.

compressed and tapers basally to a very small point of attachment, and since the present specimen is not compressed and apparently possessed a broad base of attachment, the reference to this genus is not positive.

Family FUNGIIDAE

Genus Discotrochus Edwards and Haime, 1848

Discrotrochus californicus, n. sp. Figs. 3–5

Corallum solitary, depressed-cupoloid in shape, with flat, circular base with faint scar of very early fixation. Corallite wall septothecal, thick, solid, horizontal, nonepithecate, costate Costae corresponding to all septa, alternating regularly in size, obsolescent towards center of base. Those corresponding to septa of lower cycles larger, subacute with a few stout granulations on edges. Septa 36 in number, in six systems, imperforate, highly exsert, outer margins vertical, inner ones gently convex to the circular central fossette, laterally ridged or granulated perpendicularly to margins which are peripherally crossed by transverse denticulations where opposing ridges meet over margins Septa of the fourth cycle not developed in "dorsal" half of each of the six systems. Columella trabecular, small, extending upward about half the thickness of the corallum.

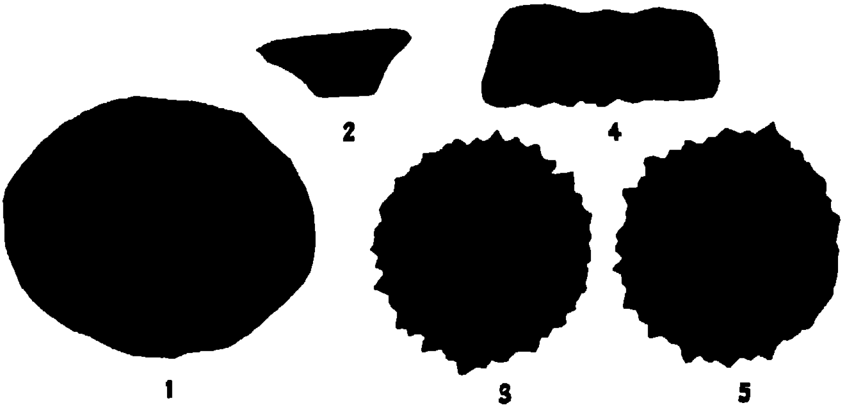

Fig. 1.—*Antilloseris? vaughani*, n. sp., holotype; oblique basal view, showing polished section of base (note absence of columella and dissepiments), ×2. Fig. 2.—Same, lateral view, ×1. Fig 3.—*Discotrochus californicus*, n. sp, holotype, view of calice, ×5. Fig. 4.—Same, lateral view, ×5. Fig. 5.—Same, basal view, ×5.

Dimensions of holotype—Diameter of corallum at base, 6 mm; height of corallum, 2.5 mm.

Dimensions of paratypes.—	(1)	(2)	(3)	(4)	(5)
Diameter of corallum	6.5	6.2	5.75	5.5	5.5 mm.
Height of corallum	3.0	2.0	2.4	2.75	2.5 mm.

Paratype 2 is much worn.

Holotype.—U.S.N M. no. 498698.

Paratypes.—U.S.N.M. no. 498699, five specimens.

Type locality.—Same as for *Antilloseris? vaughani.*

Paratype locality.—U. S. Geological Survey locality 14482a. Same horizon as type locality but on next ridge to east of type locality.

Remarks.—This species is based upon a holotype (the first collected) and five paratypes from a nearby locality. All are in a fair state of preservation and show the characters of *Discotrochus*, a genus associated by most authors with the Caryophylliinae. Recent study of the type species, *D. orbignianus* Edwards and Haime,[8] by Dr. T. W. Vaughan and the writer, however, indicates that *Discotrochus* is scarcely distinguishable from the fungid *Cycloseris* except for the rarity of synapticulae, smaller number of septa, and thicker basal wall in *Discotrochus*. The present species is distinguished from the genotype, and only other American species, *D. orbignianus*, of the lower Claibornian (Eocene) of the Gulf Coastal Plain, by the different proportions of the corallum. The ratio of height to diameter of *D orbignianus* is 1:4, in *D. californicus*, 1:2.5. The latter is therefore relatively much higher than *D. orbignianus*. Further, *D. orbignianus* usually possesses four complete cycles of septa, whereas all the specimens of *D. californicus* examined show the fourth cycle only half developed in each of the six systems.

PALEONTOLOGY.—*A new* Gisortia.[1]

WILLIAM M. INGRAM, Cornell University. (Communicated by JULIA A. GARDNER.)

The *Gisortia* described here, from the Capay stage, Llajas formation, lower zone, Simi Valley, Ventura County, Calif., is the only species belonging to this genus thus far reported from North America. It is one of the species of mollusks used by Clark and Vokes (1936) for intercontinental correlation of west-coast Eocene and European Eocene faunas. These workers have compared it to *Gisortia tuberculosa* (Duclos) from the Ypresian stage, Paris Basin, France. They state, "The California specimen [*Gisortia clarki* Ingram] is somewhat more globose and the outer lip is not as prominently reflected posteriorly as in the Paris Basin form [*Gisortia tuberculosa* (Duclos)]. The evidence indicates that in both species the spire was submerged beneath a callus wash."[2]

Gisortia clarki, n. sp.

Shell globose, heavy; posterior canal prominently produced, and covered dorsally by a shelf 8.5 mm broad on the outer side; dorsally on the columellar side this shelf narrows to a width of approximately 3 mm and slopes abruptly toward the ventral shell surface; posterior canal produced 11 mm; spire almost totally submerged beneath outer enamel, the spire peak projecting 3.5 mm from the body of the shell; a flattened surface persists to the left of the posterior canal; maximum width of posterior canal is 14 mm; estimated maximum width of anterior canal about 16 mm, a shelf with a maxi; mum width of 5 mm occupies the columellar side of the anterior canal-this shelf is angled dorsally from the shell base; the anterior canal is apparently compressed dorsoventrally at its outermost extremity; outer and columellar lips of aperture broadly rounded; aperture curves to the left anteriorly and posteriorly.

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[8] VAUGHAN, T. W. U. S Geol Surv. Mon. 39: 78–80, pl. 5, figs. 13–19b. 1900.

[1] Received February 2, 1940.

[2] CLARK, B. L., and VOKES, H. E. *Summary of marine Eocene sequence of western North America*. Bull. Geol. Soc Amer. 47: 851–878. 1936.

Dimensions—Length 121 mm, breadth 94 mm, height 64 mm.

Holotype.—Univ. California, Mus. Pal., invertebrate collection, no. 14844.

Type locality.—Locality no. 4052, Museum of Paleontology, invertebrate collection; Capay stage, Llajas formation, lower zone, Simi Valley, Ventura County, Calif.

The holotype specimen is moderately eroded on the dorsal surface The greater part of the dorsal shell convexity is represented by an intact internal mold. The shell substance is well preserved on the base, the extreme posterior region, columellar lateral shell boundary, and on the posterior three-fourths of the outer lip. The aperture is filled with a matrix, which prohibits a description of the internal surfaces of the columellar and outer lips.

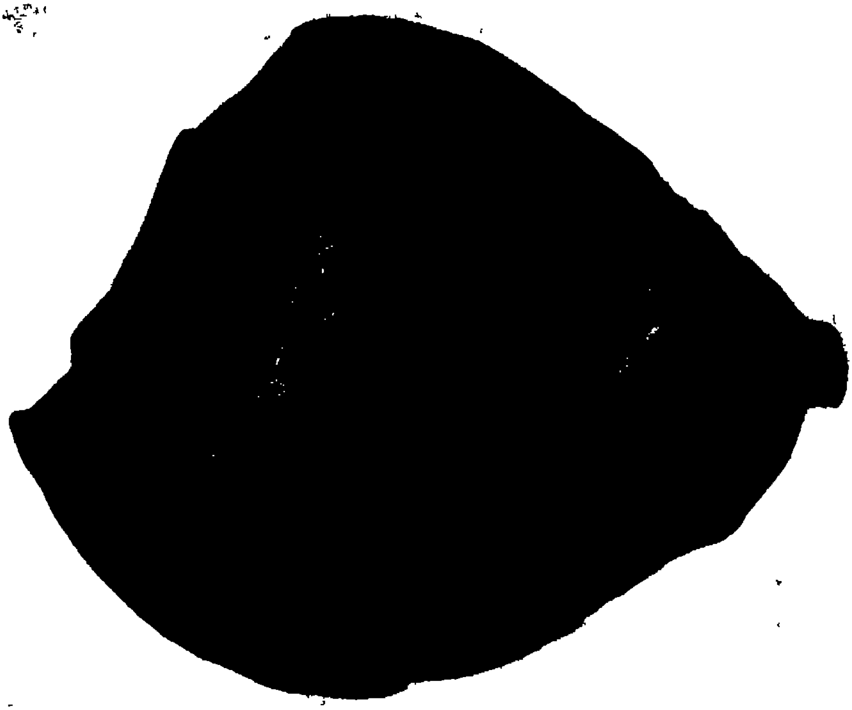

Fig 1.—*Gisortia clarki*, n sp. Dorsal view Approximately natural size.

This species is named in honor of Dr. Bruce L. Clark, of the Department of Paleontology of the University of California, Berkeley, Calif. The photograph used here was obtained through his courtesy. The holotype specimen was also sent to the writer by Dr Clark.

BOTANY.—*Spore formation in* Matula.[1] G. W. MARTIN, State University of Iowa.

The genus *Matula* was established by Massee (Journ. Royal Micr. Soc. 1888: 173) to accommodate *M. poroniaeformis*, a fungus first described from Ceylon by Berkeley and Broome (Journ. Linn. Soc. Bot. 14: 73. 1873) as *Artocreas poroniaeforme*. Berkeley believed that the species so named was congeneric with *Michenera Artocreas* Berk. and Curt., but by an error he transposed the generic and specific names of the latter species, writing it, in a note appended to the description of *A. poroniaeforme*, *Artocreas Micheneri*. Shortly afterward (Journ. Linn. Soc. Bot. 15: 83. 1876) he corrected the error, without, however, actually publishing the combination *Michenera poroniaeformis*, which he had evidently meant to use in the first place but which seems to have been first printed in the Sylloge Fungorum 6: 653. 1888. Lloyd (Myc. Writ. 3: 443. 1909) examined the specimens at Kew and satisfied himself that Berkeley had really transposed the names, and Petch in connection with his careful study of the Ceylon species (Trans. Brit. Myc. Soc. 11: 67–81. 1926) checked the situation independently and came to the same conclusion.

Massee restudied Berkeley's material and, believing that he saw basidia, made *Matula* the type and sole representative of a new "order" of Gasteromycetes, the Matuleae, which he regarded as intermediate between the Nidulariaceae and the Hymenogastraceae. Many years later Rick (Broteria 5: 10. 1906), referring to what he regarded as a distinct species, *Michenera Rompelii* Rick, from Brazil, said: "Es gehört natürlich unter die Hymenogastrineae als Hemihymenogastria." Lloyd (Myc. Writ. 2: 391. 1908) transferred Rick's species to *Matula*, and said, referring to both species: "The relations appear to be entirely with the Nidulariaceae." Petch, however, presents convincing evidence that the Ceylon species is an imperfect stage of *Peniophora habgallae* Cke.

Although Massee's supposed discovery of basidia seems clearly to be based on misinterpretation of what he saw under the microscope, his generic name has been very generally adopted. Petch, however, uses the generic name *Artocreas* on the ground that the species described by Berkeley as *A. poroniaeforme* is generically distinct from *Michenera* and was technically validly published. With this interpretation I can not agree. Berkeley believed his *A. poroniaeforme* belonged in the same genus as *Michenera Artocreas*, and his publication

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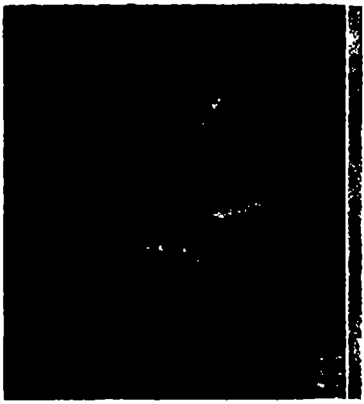
[1] Received March 21, 1940.

of *Artocreas* as a genus was no more than the result of a trick of memory, as he himself pointed out. Such publication certainly does not comply with the conditions clearly stated in Article 37 of the International Rules. Massee was the first to recognize the generic distinctness of *Matula*, and, however erroneous certain of his conclusions may have been, his description does bring out the characteristics by which the genus may readily be recognized. So long as it is regarded as distinct from *Michenera*, his name should be applied.

Berkeley described the spores of *A. poroniaeforme* as 0.0009 inch in diameter (24–25μ). *Michenera Rompelii* Rick (Ann. Myc. **2**: 243. 1904) was based largely on the supposedly smaller spore size, less than 20μ. Lloyd reported the spores of both species to be 18–20μ in diameter and concluded they were probably the same. Petch, however, noted certain differences between them, particularly a continual basal layer beneath the cup in *Rompelii*, which he finds lacking in *poroniaeformis*, and concludes that it is doubtful whether they are identical.

A species of *Matula* was fairly common in western Panamá in July 1935, being represented by five collections. Four of these are from the valley of the upper Rio Chiriquí Viejo, above 1,600 m., and the other is from the forest south of the Llanos del Volcán between 1,100 and 1,200 m. I have also a single collection from the Sierra Nevada de Santa Marta, Colombia, between 1,250 and 1,500 m. gathered in August of the same year. In addition, I have examined one of Rick's collections from Brazil, now in the Lloyd Herbarium at Washington (no. 22541) and a collection of G. H. Cunningham's from New Zealand, now in the herbarium of the Missouri Botanical Garden. All, I am convinced, represent the same species. Some fructifications appear to have the continuous basal layer beneath the cup referred to by Petch as characteristic of the American forms, but others lack it, appearing in section, except for the absence of bark fragments imbedded in the fructifications, essentially like the forms illustrated by Petch in figures 1–5 of his plate 3. As in the Old World specimens, the fructification is at first subglobose and closed, opening above very early and assuming the characteristic cupulate form. The spores are borne in peridiole-like chambers, originating from the walls of these chambers. In the older portions near the surface the walls disappear, at which time this part has become a solid mass of the large, thick-walled spores, held together by their gelatinous walls (Fig. 2). The fructification is tough-gelatinous when fresh, drying somewhat horny, but readily regaining its original texture and appearance when soaked (Fig. 1). The temptation is strong to regard the New World and New Zealand specimens, on the one hand, and the Ceylon specimens studied by Berkeley, Massee, and Petch, on the other, as referable to the same species. The manner of spore development in the former group, as I interpret it, differs decidedly, however, from Petch's account for the Ceylon form, and while a careful reading of Petch's paper makes it seem not entirely impossible that his is merely a different interpretation of the same structures, in the absence of opportunity to examine Ceylon collections, it seems proper to refer the specimens here discussed to *Matula Rompelii* (Rick) Lloyd.



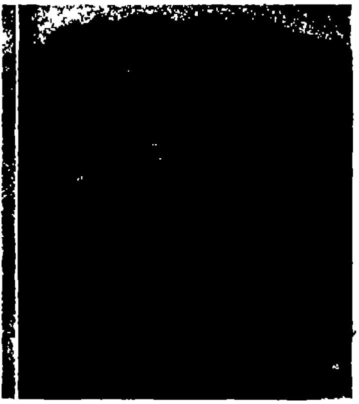


Fig. 1.—*Matula Rompelii* (Rick) Lloyd. Group of four fructifications, soaked, ×3
Fig. 2.—*Matula Rompelii* (Rick) Lloyd. Longitudinal section through fructification near center, showing peridium, basal chambers, and solid mass of spores at surface, ×15.

According to Petch, the spores of *poroniaeforme* are borne on conidiophores that produce first a terminal spore, additional spores being borne basipetally. The lumen of the young spores stains deeply but the wall surrounding it remains hyaline and gelatinous, fusing with adjoining hyphae so that the outline is indistinct. Finally, the central protoplasmic mass develops an independent wall of its own, and the wall of the parent cell deliquesces, freeing the spore. We have, then, a conidium formed within a sac, surely a curious phenomenon. Petch argues that such a spore can not be a chlamydospore and regards the spore of *Matula poroniaeformis* as homologous with that of *Michenera Artocreas*, the essential difference being that in the latter species the wall of the mother cell persists as an apical appendage and a basal pedicel, while in the former species the wall gelatinizes and disappears. Petch notes that the hyphae of *Matula* bear clamp connections, but he makes no mention of any relationship between such structures and the spores.

In the American forms studied, including Rick's Brazilian collection, and also in the New Zealand material, clamp connections are abundant on the hyphae at the bases and sides of the spore sacs, where the spores are being formed (Fig. 3, *a*). but are only rarely and obscurely visible elsewhere. I have never seen any suggestion of conidiophores, as described by Petch. The spores seem always to originate as intercalary structures on the hyphae and always at the apical side of a clamp connection. This is uniformly apparent in the young spores but progressively less so as the spores mature. The contents of the apical cell are retracted toward the septum, causing a pronounced swelling (Fig. 3, *b*, *c*, *d*). The lumen stains deeply, while the outline of the thick, gelatinous wall is very faint. Sooner or later this wall ruptures or is dissolved, and then the spore appears to be terminal (Fig. 3, *d*, *e*, *h*). Finally it breaks loose from the stalk and gradually becomes globose, apparently developing, in its later stages, at the expense of the gelatinous matrix in which it is imbedded. At complete maturity (Fig. 3, *j*) the lumen occupies approximately two-thirds of the total diameter of the spore. The wall is composed of two layers, an outer highly refractive portion, at complete maturity 0.6–0.8μ thick, and an inner clear layer 3–4μ thick or somewhat more. Occasionally the inner layer is divided by faint, concentric rings into two or more portions. Six or eight conical projections arise from the lumen and reach nearly or quite to the outer spore coat. Two or three of these are usually visible when the lens is focused on the optical center of the spore. It is not improbable that these represent germ-

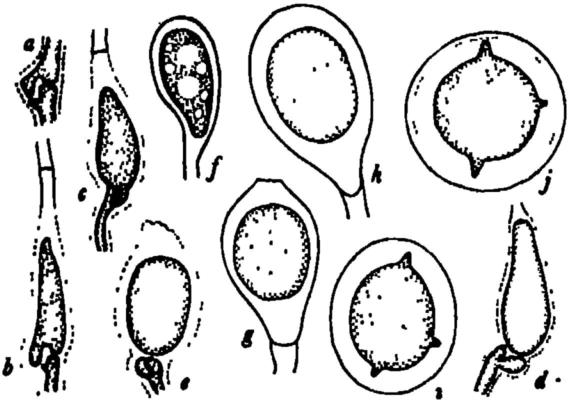


Fig. 3.—*Matula Rompelii* (Rick) Lloyd: *a*, A clamp connection from region of spore formation; *b*, *c*, *d*, early stages in spore formation, showing accumulation of protoplasm on distal side of clamp connection; *e*, *f*, *g*, *h*, progressive stages in development of spore; *i*, spore freed from basal hypha, projections arising from lumen; *j*, mature spore with double wall. All ×1,000.

pores. The outer wall above them appears, however, to be perfectly homogeneous. It seems clear that spores formed in the manner described can not be referred to as conidia, and the term chlamydospore comes nearer than any other to describing their true nature.

The spores of the Brazilian specimen are more variable in size than those of the Panamá and Colombia material, some of them reaching 28μ in diameter, and the peglike protrusions from the lumen, while often present, are usually fewer in number and sometimes not evident. I doubt whether such differences are of taxonomic significance.

No suggestion of possible connection with a perfect stage is to be found in any of the material at hand. Lacking information to the contrary it may be assumed that any perfect stage will prove to be a member of the Thelephoraceae.

ZOOLOGY.—Boccardia proboscidea, *a new species of spionid worm from California.*[1] OLGA HARTMAN. (Communicated by WALDO L. SCHMITT.)

The commonest representative of the family Spionidae, of the genus *Boccardia*, occurring in the intertidal zones of California, remains unnamed and undescribed. This species is of interest not only because it occurs in abundance in the littoral zones where it is readily available but also because of several biological features, which may warrant more thorough investigation.

My attention was first called to this species several years ago, when I was a member of Prof. S. F. Light's courses in invertebrate zoology at the University of California. At that time its designation was questionable, and after a perusal of the literature I (Univ. California Publ. Zool. **41**: 48. 1936) referred it to *Boccardia natrix* (Söderström) without, however, consulting Söderström's type materials. Since then the species has been noted many times along the coast of California. At the Scripps Institution of Oceanography, through the courtesy of Dr. Martin W. Johnson, it was possible to observe it also as an element in the plankton and to maintain adults and larvae under laboratory conditions.

This study has been supported through a grant from the American Association of University Women. I wish to express my thanks not only for the privileges already mentioned, but also to Dr. Waldo L. Schmitt, of the United States National Museum, for further courtesies.

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[1] Received March 30, 1940.

Boccardia proboscidea, n. sp. Fig. 1

?*Polydora californica* Treadwell, Univ. California Publ. Zool. 13: 203–204, pl. 12, figs. 23–29. 1914 (not *Spio californica* Fewkes, 1889, which is a *Polydora*, sensu latiore).

Boccardia natrix Hartman, Univ. California Publ. Zool. 41: 48. 1936. Journ. Washington Acad. Sci. 26: 32. 1936 (not *Polydora natrix* Söderström, 1920; *not* Berkeley, 1936).

The general form of the body is long, depressed, widest in the region of the eighth to sixteenth segments, and tapers gradually posteriorly. Number of segments is about 125 to 150; total length 30 to 35 mm but capable of much greater extension in life; greatest width (preserved) is about 1.5 mm. Color in life is deep yellow to orange, with bright-red branchial filaments, and considerable dusky pigment along the prostomial ridges and palpal grooves; in preserved individuals all color fades except the sooty markings along the prostomium and some along the palpal length.

The prostomium is an elongate, entire lobe, without median groove such as characterizes most species of this genus; a weakly developed emargination is visible only on the ventral side (Fig 1, *a*). The lobe is snoutlike (for which the specific name is proposed), it extends posteriorly between the palpal bases where it forms a low crown visible in lateral view (Fig. 1, *d*) and passes more posteriorly as a low, broad ridge to the posterior margin of the third setigerous segment (Fig. 1, *b*). In the region just anterior to the insertion of the palpal bases there are two or three pairs of dark eye spots, clearly visible when the palpi are pushed somewhat to the side. In immature specimens there may be several additional dark spots in these areas, but at least two pairs persist even in the largest individuals. The prostomial lobe is sharply set off from the peristomium by grooves at the sides of the snoutlike elevation. The lateral and ventral sides of the oral opening are bounded by the apodous, achaetous peristomial ring (or first segment). Except for some longitudinal and transverse furrows and some wrinkles of contraction, it is quite smooth (Fig. 1, *a*, *b*, *d*).

The second segment (herein designated the first setigerous) is proximal to the peristomium; it bears a dorsal and a ventral fascicle of pointed setae, each provided with a small postsetal lobe (Fig. 1, *d*). These parapodial structures are comparatively weakly developed, less than half as large as those of the following segment, the setae both fewer in number and shorter. The second setigerous segment resembles the next two. There are well-developed setigerous fascicles, the dorsal and ventral postsetal lobes are auricular, and there is a long, filamentous branchia (Fig. 1, *d*). The fifth (modified) setigerous segment is nearly twice as long as the preceding; it is provided with a dorsal fascicle of stout hooks and an inconspicuous ventral fascicle of capillary setae (Fig. 1, *i*); there are no postsetal lobes. The stout hooks are of two kinds—a longer, falcate, smooth hook, accompanied by an equally heavy, though shorter, bushy-topped seta. In unworn condition (Fig. 1, *h*) the falcate spine terminates distally in a tapering fang; the other has a characteristic subterminal constriction, then widens suddenly and ends in a spinous cap that is strongly asymmetrical (Fig. 1, *h*). In worn condition both of these spines lose these characters (Fig. 1, *j*), but the cuplike base of the latter is still notable.

The next (sixth setigerous) segment is provided with pointed setae in both dorsal and ventral fascicles; its structures are similar to those of the second to fourth segments, but the postsetal lobes are progressively larger. From the seventh the neuropodium is provided with about eight hooded

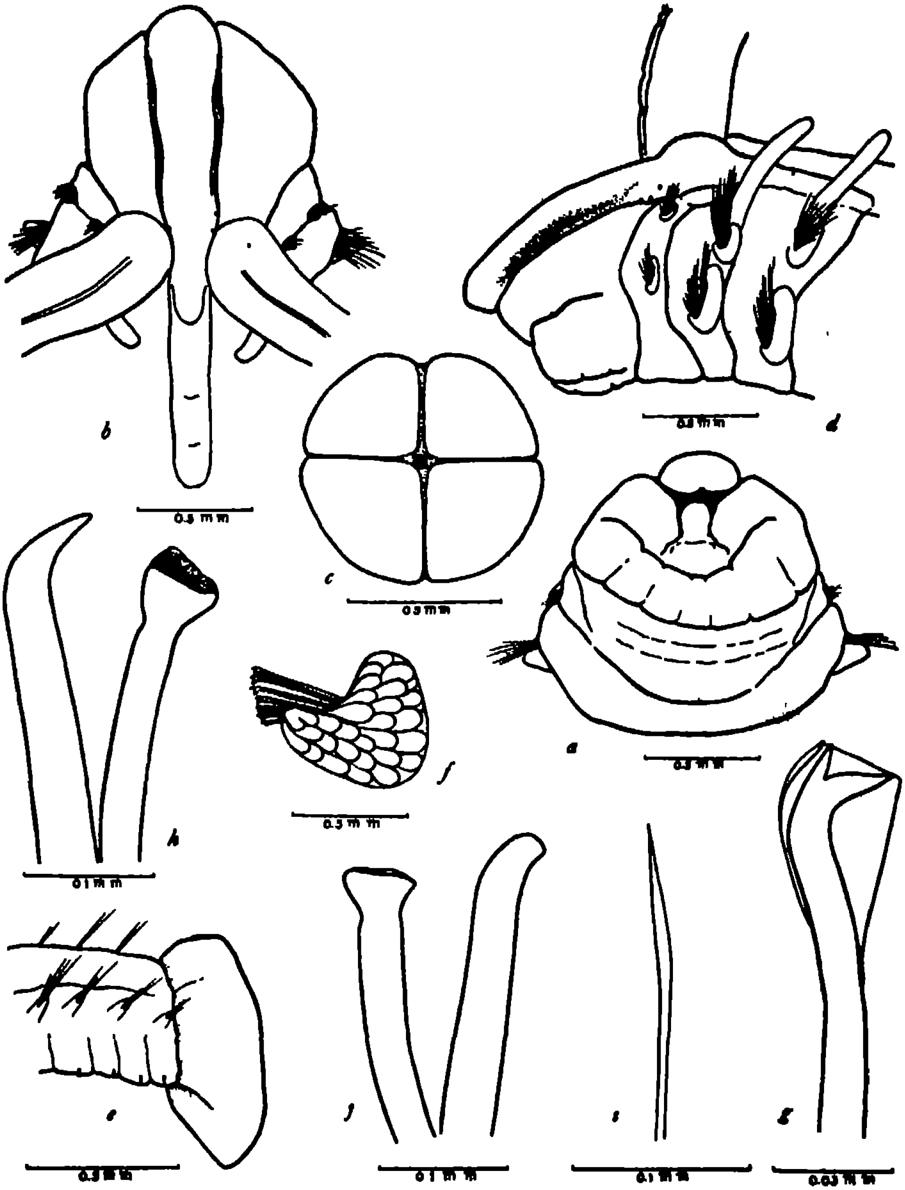

Fig. 1.—*Boccardia proboscidea*, new species: *a*, Anterior end, in ventral view, showing the rounded margin of the prostomial lobe and the peristomial ring bounding the oral aperture, followed by the first two setigerous segments; *b*, the same, in dorsal view, with only the palpal bases shown, the prostomial caruncle continued posteriorly; the eye spots are largely hidden because of their position at the sides of the prostomial lobe; *c*, anal disk in posterior view, showing the 4-lobed arrangement; *d*, anterior end from the left side, the left palpus removed so that the eyes may be seen, setal fascicles indicated; *e*, posterior end from the left side, showing the prolongation of the ventral lobes of the disk; *f*, parapodial gland from the ninth segment seen from the front, showing its characteristic outline; *g*, hooded crotchet from tenth neuropodium; *h*, companion stout setae from the fifth setiger in unworn condition; *i*, pointed seta from inferior fascicle of the modified fifth setigerous segment; *j*, worn companion setae from the fifth setigerous segment.

crotchets, disposed in a single vertical series, and a smaller, inferior fascicle of about five or six slender, pointed setae. The latter persist through about four segments, but from the eleventh there are only hooded crotchets. Notopodia are provided with only pointed setae throughout. Hooded crotchets of anterior and posterior segments resemble one another. The distal end is bifid, the lateral fang nearly at right angles to the main stem, the distal tooth smaller (Fig. 1, *g*).

Branchiae are distributed on setigerous segments 2 to 4, and from the sixth to near the posterior end; the last few (two to four) segments are abranchiate. Setigerous glands, characteristic of members of this family, are best developed posterior to the modified segment; they form a thick, sacklike, slightly L-shaped, pouch (Fig. 1, *f*), terminating under the body wall adjacent to the hooded hooks. The last setiger is followed by a broad, flaring anal disk (Fig. 1, *c*, *e*) unequally 4-lobed, the dorsal lobes the smaller. The anal aperture lies in the depression near the center of the disk (Fig. 1, *c*).

B proboscidea is thus characterized in having branchiae distributed on setigerous segments 2 to 4, and from segment 6 nearly to the posterior end; the first setigerous segment has weakly developed nodopodial and neuropodial fascicles; hooded crotchets are present from the seventh, the first few accompanied by an inferior fascicle of pointed setae, the rest forming a single series of hooks only; the prostomial lobe is long, entire, snoutlike, without median emargination; it is continued posteriorly as a ridge to the posterior margin of the third setigerous segment; the modified segment is provided with smooth falcate setae and bushy-topped setae in which the spinous area is asymmetrical. Its affinities are with *B. polybranchia* (Haswell), from which it differs in its entire prostomial lobe and in having setal fascicles both dorsally and ventrally in the first setigerous segment. Another nearly related species is *B. natrix* (Soderström), but this has well-developed parapodial lobes on the first setigerous segment and the prostomial lobe is bifid; also the bushy-topped setae have paired bosses subdistally.

Holotype.—U.S.N M. no. 20217. Caspar, Calif.

Distribution.—*B. proboscidea* inhabits a great variety of niches in the intertidal zones of California, south at least to San Diego and north to Mendocino, but its range may extend north to Puget Sound, Wash. It has never been encountered in dredged collections from deeper water. Careful investigations in other areas, however, may extend these ranges.

Biology.—*B. proboscidea* is conspicuously abundant in shale and limestone reefs, penetrating the softer rocks, boring usually at right angles to the surface, and sometimes present in such numbers as to cause the rock to break away. It is also an interesting dweller in high tide pools, where hollows are formed in sedimentary rocks. In such places the minute burrows of the spionid may be observed at the apertures of which the two long, waving palpi of the worm reach far out, after particles of food in the vicinity. A common association in such pools is with a small red harpacticoid copepod, of the genus *Tigriopus*, on which the spionid feeds. Prof. S. F. Light, of the University of California, has often called attention to this association, as well as to the high incidence of the *Boccardia* in these areas. An abundance of the latter is usually correlated with small numbers of *Tigriopus*. Its presence in such habitats is also indicative of great tolerance for variations in salinity and temperature. Another favorite habitat is in narrow crevices in intertidal zones. Under such conditions a loosely constructed tube surrounds the individual.

B. proboscidea is a voracious predator, feeding not only on algal particles, Bryozoa, Hydrozoa, and other attached organisms but actually capturing free-swimming animals. The greatly extensile, prehensile palpi are the chief organs of food getting; the tip senses out favorable objects for ingestion and is firmly wrapped about any desirable object that is nipped off, taken up in the ciliary groove, moved orally, and swept into the mouth.

Only fragmentary information is known of the life history. The eggs are deposited in ovoid capsules, 50 or more eggs in each, and five or more capsules in a tube. Aeration, produced by rhythmic movement of the adult, is continued while the young develop. The rate of development in any one capsule may be about equal for the various individuals, or very irregular. Development is fairly rapid and can be conveniently observed because of the ease with which they develop under laboratory conditions.

Capsules collected from the tube of a single adult differ among themselves. Some will have numerous larvae, all in a similar stage of development, with as many as 40 or more rapidly moving young When such a capsule is split open there is a great scurry to escape. If given nourishment, they flourish as plankton organisms and after some weeks metamorphose into settling young. In other capsules there may be only one or two much larger larvae, cannibalistic on the other contents in the capsule, and escaping only when all food has been used. Whether the other eggs fail to develop because of injury or some enzymatic influence has not been ascertained. At any rate, when such young emerge they are ready to settle immediately. Incidence of the larvae in the plankton is readily observed because of a unique pigmentation pattern; already in a 7- to 9-segmented stage the modified segment is differentiated.

Systematic discussion —Several species of *Polydora* (sensu latiore) have been described from the west coast of the Americas, but the status of some of them is still in doubt. Unless type specimens are extant, some of the names may need to be dropped. The first spionid to be described from California was *Spio californica* Fewkes (Bull. Essex Inst. 21: 37–38. 1889) from Santa Barbara. It is difficult (perhaps impossible) to know what this is, but it must be considered in this discussion because of the statement, "On the second, third and fourth body segments, counting from the head, we find a dorsal and ventral bundle of setae, and a dorsal and a ventral cirrus. The ventral cirrus [postsetal lobe?] is smaller than the dorsal. In the fifth body segment [modified segment?] there is a fan-shaped, deeply embedded bundle of large spines in addition to the dorsal and ventral clusters." There is, however, no mention of the distribution of branchiae, nor is it clear that the author distinguished between branchiae and postsetal lobes, nor what is meant by dorsal and ventral cirrus. It is not possible to distinguish it as either a *Boc-*

cardia or *Polydora* (sensu stricto). There is another statement regarding its tubes, which contradicts its inclusion in the family Spionidae: "The tubes . . . resemble those of *Sabellaria* but differ from them in color, size, and form of the openings. The edges of the orifices are sharper and the tubes themselves are more compact." I know of no spionid which constructs such tube masses. However, the head is said to have "two long tentacles" (as in Spionidae) but they are described as papillated (Magelonidae??). Other features exclude it from the latter. I am unable to regard this as anything more than a *Polydora* in the broad sense.

Later *Polydora californica* Treadwell (Univ. California Publ. Zool. 13: 203–204, pl. 12, figs. 23–29. 1914) was described, its locality given as unknown. I have seen the single incomplete specimen, deposited in the collections of the University of California It may be the same as the species herein described, but since the name turns out to be a questionable homonym, it should be replaced by another A few years ago, while going over the collections at Berkeley, I reported this as *B. natrix* (Univ. California Publ. Zool. 41: 48. 1936), and identified Treadwell's name with it. Since then, I have seen Söderström's type of *B. natrix* and found it to be something quite different. Through the courtesy of Prof. Sixten Bock, of the Swedish State Museum at Stockholm, these materials were made available. The results are being reported on in a separate study. It is sufficient here to say that *B. natrix* is an inhabitant of a sponge, from a depth of 135–150 meters, off southern South America, that it is clearly separable morphologically from the California species, and that *B natrix* can not be applied to the latter. *B. natrix* has a prostomial lobe that is clearly bifid at its anterior margin, the groove continued for some distance along the dorsal surface; there are eye spots but differently disposed; the first setigerous segment has unusually well developed fascicles and postsetal lobes, nearly or quite as large as those of the following segments, and the modified hooks of the fifth segment are provided with paired lateral bosses. *Polydora* (*Boccardia*) *natrix* was later reported by Berkeley (Ann. Mag. Nat. Hist. (10) 18: 472. 1936) from the Nanaimo district. These specimens are partly described, showing therein differences from Söderström's species, but differing also from *B. proboscidea.* Dr. Berkeley recorded the absence of eyes and described the prostomium as bifurcate.

ZOOLOGY.—*Notes on the amphipod* Gammarus minus *Say and description of a new variety,* Gammarus minus *var.* tenuipes. Clarence R. Shoemaker, U. S. National Museum.[1]

Thomas Say (1818, p. 376) described *Gammarus minus* as follows:

> Eyes reniform; superior antennae longer than the inferior ones, terminal joint with about twelve articulations. Inhabits rivulets and small fresh-water streams. Body whitish, with a few very pale fulvous lateral spots; eyes blackish, placed at the exterior base of the superior antenna; superior antennae obviously longer than the inferior ones, seta short, attaining the tip of the second articulation of the terminal joint, terminal joint with about twelve articulations. Length three-twentieths of an inch. Found in brooks under stones, and may be readily discovered by taking a stone out of the water, and inspecting its inferior surface.

His description would be quite inadequate for the recognition of the species, except for his mentioning that the first antennae are obviously longer than the second and that it inhabits rivulets and small fresh-water streams. It is, as he states, an inhabitant of the small streams, and, though he does not say streams of the east coast, he undoubtedly means such, as all the other amphipods he described were from the east coast. It is a very common and widely distributed species of the cold streams of the eastern section of the United States, in contradistinction to *Gammarus fasciatus* Say, which inhabits the warmer waters of our eastern rivers.

Though *Gammarus minus* is so common and widely distributed, there have been comparatively few references to it in literature since its discovery in 1818. H. Milne Edwards (1840, p. 46) says that the species described by Say under the name of *Gammarus minus* does not seem to differ in any important character from *G. fasciatus* and it will perhaps be necessary to unite them. A. A. Gould (1841, p. 334) says, "Found [in Mass.] in ditches and sluggish fresh water, adhering to sticks." Since the habitat he cites does not seem suitable for *G. minus*, it is doubtful whether his reference applies to this species. J. E. DeKay (1844, p. 37) says, "This species is common [in New York] in most of our fresh-water streams, and may often be detected under stones and pieces of wood. It is extremely active, and is popularly known under the name of *Fresh-water Shrimp*." He gives a short description, but fails to add any useful characters, and he also gives a very small inaccurate figure. Adam White (1847, p. 88), in his *List of the specimens of Crustacea in the collection of the British Museum*,

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[1] Published by permission of the Secretary of the Smithsonian Institution Received April 11, 1940.

uses the name *Gammarus minimus* Say and gives the locality as United States; specimens presented by Thomas Say. Spence Bate (1862, p. 221), in *Catalogue of the specimens of amphipodous crustaceans in the collection of the British Museum*, repeats Say's description and habitat.

Sidney I. Smith (1874, p. 654) says, "I have not yet been able to rediscover this species, which is very likely not a true *Gammarus*." He believes that the specimens referred to by White and Bate were the ones that Bate described as *Allorchestes knickerbockeri* (1862, p. 36). Lucien M. Underwood (1886, p. 357) mentions the species as occurring doubtfully in New York. Thomas R. R. Stebbing (1906, p. 513) puts *G. minus* in the list "Gammari nominatim, reapse incertae sedis." Henry W. Fowler (1912, p. 194) in *The Crustacea of New Jersey*, lists *Gammarus minus* Say and questionably *Lepleurus rivularis* Rafinesque as synonyms of *Gammarus fasciatus* Say. From the localities he cites for *G. fasciatus* it is quite evident that he is dealing with both *G. fasciatus* and *G. minus*.

As the references to *Gammarus minus* in literature add nothing to Say's inadequate diagnosis, I here redescribe and figure the species from specimens collected by John W. Price from a small stream at Gable's Woods, Lancaster, Pa., on March 6, 1936. As Say did not designate any locality, a male from this lot has been selected as the neotype, U.S.N.M. no. 79152. I have selected this locality for the neotype because Say collected *G. fasciatus* at Philadelphia, and it is probable that he also collected *G. minus* in the brooks of the surrounding country, which would be only about 60 miles from Lancaster.

Gammarus minus is placed by Dr. A. Schellenberg (1937, p. 270) in the subgenus *Rivulogammarus*, which he established for those almost exclusively fresh-water species of the cold and temperate regions of the northern half of the earth. He characterized this subgenus as having the side lobes of the head truncate or rounded off without the sharp upper corner. Eyes mostly small, oval or kidney-shaped. First and second urosome segments without or with only weakly developed central humps and with only one pair of central spines. Third urosome segment mostly without central spines. A part of the urosome spines sometimes replaced by bristles. Accessory flagellum 1- to 6-jointed. Lower margin of the coxal plates mostly unbristled. Metacarpus of the first gnathopod of male with peglike spines on rear margin. Rami of the third uropod varied in length, but the inner ramus never reduced to a scalelike joint.

Gammarus (Rivulogammarus) minus Say Figs. 1, 2

Gammarus minus Say, Journ. Acad. Nat. Sci. Philadelphia 1(2): 376. 1818.
G. propinquus Hay, Proc. U. S. Nat. Mus. 25(1285): 224. 1902.
G. purpurascens Hay, Proc. U. S. Nat. Mus. 25(1292): 433, fig. 7. 1902.

Male.—Head with lateral lobes squarely truncate, upper and lower angles of lobes rounding. Eyes large, black, reniform, and slightly broader below. Antenna 1 about two-thirds the length of the body and considerably longer than antenna 2; first joint of peduncle a little longer than second, which is about twice as long as third; flagellum of about 30 joints; accessory flagellum of three or four long joints and a very minute terminal joint. Antenna 2, gland cone of second joint prominent; third joint prominent; fourth and fifth joints about equal in length; flagellum nearly as long as fourth and fifth joints combined and consisting of about 14 joints, the first five or six of which bear calceoli.

Right mandible with cutting edge rather narrow and armed with four teeth; accessory plate with double cutting edge; five spines in spine row; molar strong and bearing two short plumose setae on front margin and a long seta on inner margin; second joint of palp slightly longer than the third. Inner plate of maxilla 1 with about 16 plumose setae; outer plate with 11 spine teeth, some of which are blunt and some pectinate; palp of right maxilla broad, armed distally with four or five stout teeth, one slender pectinate spine tooth, and one slender plumose seta; palp of left maxilla with about seven slender spine teeth and four slender setae Maxilla 2 normal and bearing the usual oblique row of plumose setae on inner plate. Maxillipeds with inner plate narrower, but nearly as long as outer plate, bearing distally three spine teeth and numerous slender curved plumose spines, inner margin bearing long, slender, plumose setae and one short spine near the upper angle; outer plate armed with a row of spine teeth on distal inner margin, a row of curved plumose setae on distal margin and numerous submarginal setae near the inner margin; palp rather short and stout, third joint with a low distal lobe, the inner edge of which extends obliquely across the inner face of the joint bearing a row of serate spinules; fourth joint rather slender and armed distally with a fine nail at the base of which are several closely set setules. Lower lip with broad blunt side lobes.

Coxal plates 1 to 3 bearing a few spinules at the rounding anterior and posterior corners. Coxal plate 4 bearing a few setules at anterior corner and a row on the lower posterior margin Sixth joint of gnathopod 1 with the very oblique palm bearing a stout central spine and a stout defining spine, hind margin and inner surface of joint bearing several short blunt spines. Sixth joint of gnathopod 2 with front and hind margins about parallel, the oblique palm bearing a stout central spine and two stout spines at the broadly rounding defining angle, inner surface of joint bearing two small submarginal spines at defining angle. Peraeopods 1 and 2 very similar in structure, but 1 the longer and stouter and bearing longer and more numerous bristles Second joint of peraeopod 3 broad, with the lower hind margin forming a prominent angle. Peraeopods 4 and 5 about equal in length, second joint with distinct lower hind angle.

Metasome segments 2 and 3 with lower hind corners sharply produced, lower margins bearing spinules and hind margins setae. Urosome segments 1 and 2 somewhat raised dorsally, and each bearing the two median dorsal spines characteristic of the subgenus *Rivulogammarus*. Urosome segment 3 may have either one or two median dorsal spines, or it may be without any,

but there are always median setae. Urosome segments 1 to 3 may bear either one or two lateral spines on either side. All urosome spines are accompanied by setae or bristles.

The number of spines on uropods 1 and 2 varies with the size of the specimen, but the number is always small. Uropod 3 with inner ramus about two-thirds the length of the outer, and both rami furnished on their margins with fascicles of long setae. Outer ramus without plumose setae on the second joint or apex of first joint; outer margin of first joint with a plumose seta in each fascicle except those which contain spines; inner margin with a plumose seta in each fascicle. Inner ramus without plumose setae on apex, but outer and inner margins with a plumose seta in each fascicle.

The telson varies somewhat in different individuals; the general arrangement being a single lateral spine accompanied by several setae, three apical spines with long setae on each lobe, and a group of lateral setae near the apex of each lobe. Occasionally there is an extra lateral spine either above or below the regular lateral spine. Length of the largest males about 16 mm.

***Female.*—The gnathopods are smaller than in the male, and the fifth and sixth joints of gnathopod 2 are much narrower and are about equal in length. Antenna 2 bears no calceoli. Uropod 3 shorter than in the male.**

Remarks.—There are in the National Museum females of *Gammarus minus* from the District of Columbia carrying eggs each month from January to August. There are hatched young in the marsupium in January, April, May, June, and August. Free-swimming young are found in January, April, July, and August collections There are no specimens taken in the District of Columbia from September to December, but specimens from Virginia and Pennsylvania taken in November and December carry eggs. It appears, therefore, from these records that the species breeds throughout the year.

Specimens of *G. minus* from a cave at Speed Creek, about 8 miles northeast of Bedford, Lawrence County, Ind., and those from a cave on the Mullindore property, Rohrersville, Washington County, Md., differ very slightly from the normal surface water form.

In the National Museum there are collections of *G. minus* from Pennsylvania, Maryland, District of Columbia, Virginia, West Virginia, Indiana, Tennessee, Kentucky, and Georgia.

I have examined the type material of *Gammarus propinquus* Hay from a spring about 2 miles north of Mammoth Cave, Ky., and of *G. purpurascens* Hay taken at the mouth of Nickajack Cave, Shellmound, Tenn., and I find that they do not differ specifically from *G. minus* Say. Hay does not give the measurements of either species, but the largest specimens of *G. propinquus* are about 10.5 mm from the front of the head to the tip of the third uropods, and those of *G. purpurascens* are about 10 mm. The specimens collected by Hay in spring at Rossville, Ga. (referred to in Proc. U. S. Nat. Mus. 25: 434. 1902) and identified as *G. purpurascens*, are in the National Museum. They are all of medium size, the largest about 9 mm and are undoubtedly *G. minus* Say.

The *Lepleurus rivularis* of Rafinesque (1820, p. 7) said to occur in the brooks of the mountains of Pennsylvania and at Shannon Run and Bedford

Springs, Va., is probably the *Gammarus minus* of Say, but Rafinesque's description is so imperfect that nothing can be learned from it.

Gammarus minus var. tenuipes, new variety

Specimens from Organ Cave, Greenbrier County, W. Va., found in a stream a quarter of a mile in from the entrance, appear to be a subterranean variety of *Gammarus minus*. These specimens have the eye greatly reduced and occasionally almost entirely lacking. The lateral lobes of the head have the corners very rounding. The gnathopods and peraeopods are slender, especially noticeable in the narrowing of the second joint of the last three peraeopods. In some of the specimens there is a reduction in the number of spines on the urosome. The inner ramus of the third uropod is proportionately longer than in the normal form. The whole animal has a weaker and more delicate appearance than the surface form. Length about 14 mm.

The type, a male, U.S.N M. no. 79195, was taken in Organ Cave, Greenbrier County, W. Va., on October 21, 1939, by T. Kenneth Ellis.

The National Museum has also a specimen of this variety from McClung's Cave, West Virginia, and several from Higgenbotham's Cave, Frankford, Greenbrier County, W. Va , collected by J. M. Valentine.

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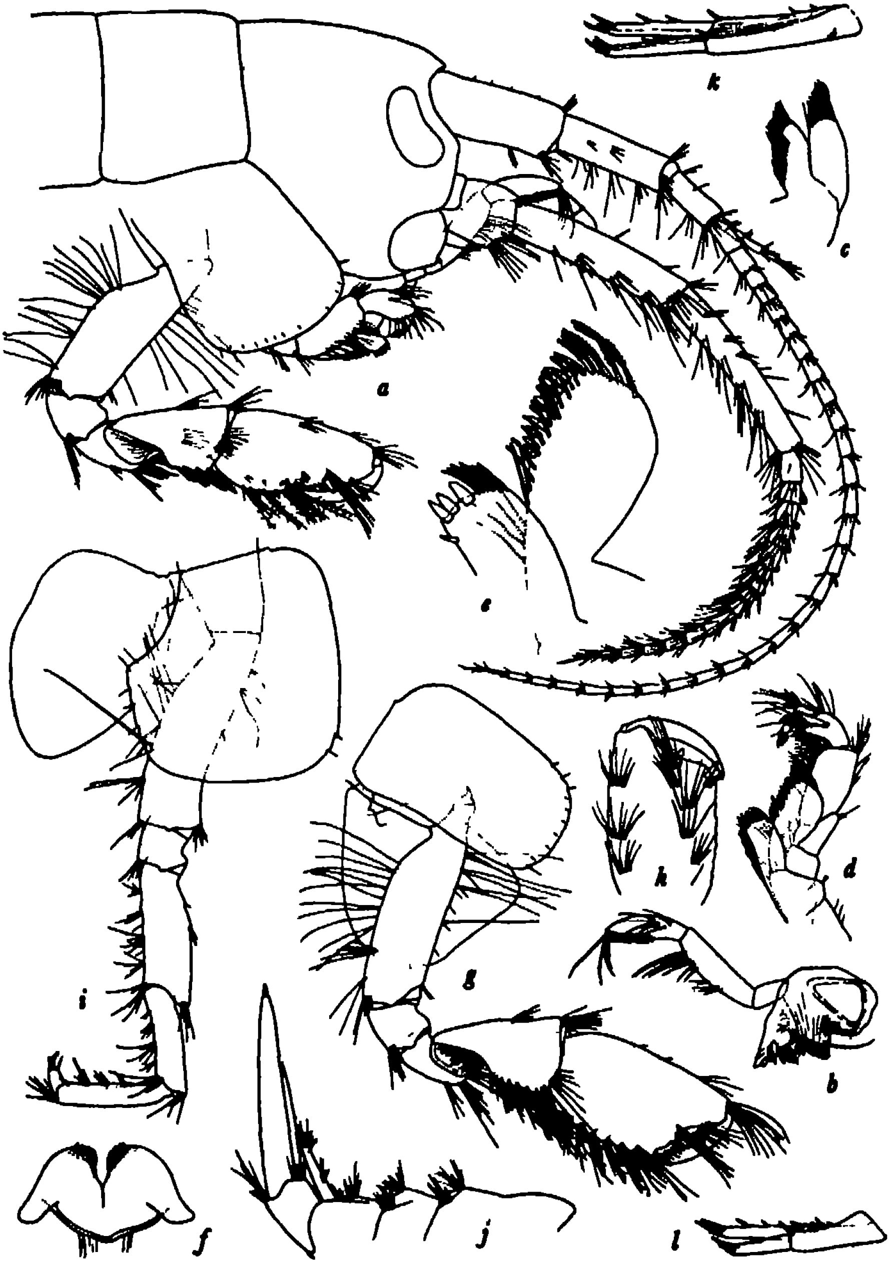

Fig. 1.—*Gammarus minus* Say, male: *a*, Anterior end of animal; *b*, right mandible; *c*, maxilla 2; *d*, right maxilliped; *e*, inner and outer plates of maxilliped on larger scale; *f*, lower lip; *g*, gnathopod 2; *h*, inner surface of metacarpus of gnathopod 2; *i*, peraeopod 2; *j*, urosome; *k*, uropod 1; *l*, uropod 2.

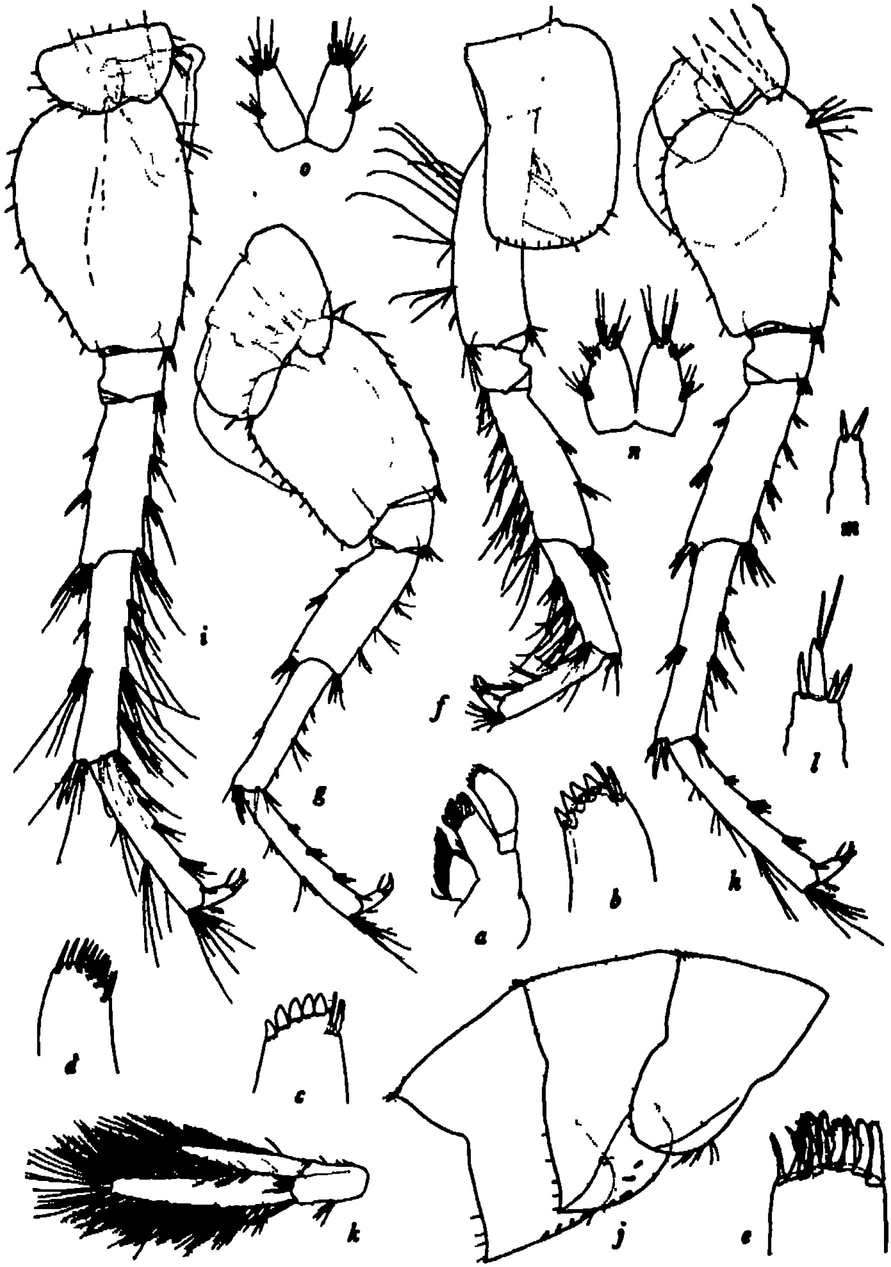

Fig. 2.—*Gammarus minus* Say, male: *a*, Right maxilla 1; *b*, palp of maxilla 1 on larger scale; *c*, palp of another male showing five spine teeth; *d*, left palp showing terminal spines; *e*, distal end of outer plate of maxilla 1 showing the 11 spine teeth; *f*, peraeopod 1; *g*, peraeopod 3; *h*, peraeopod 4; *i*, peraeopod 5; *j*, metasome; *k*, uropod 3; *l*, *m*, apex of outer and inner rami of uropod 3 on larger scale; *n*, telson; *o*, telson of another male. The figures of telson are on a slightly larger scale than the uropods.

ZOOLOGY.—*A new harpacticoid copepod from North Carolina.*

R. E. Coker and Juanita Morgan, University of North Carolina. (Communicated by Waldo L. Schmitt.)

Harpacticoid copepods collected by a graduate student, Paul McKee, from Baker Lake (Bladen County), Swamp Pond (Craven County), Odum's Millpond (Cumberland County), and other waters of eastern and southeastern North Carolina were found to resemble in many respects both *Canthocamptus staphylinoides* Pearse (1905) and the subspecies that the senior author has described as *sinuus* (1934). There are, however, such notable points of difference from one or both of these forms that it merits at least subspecific designation. We have named it:

Canthocamptus staphylinoides vagus, new subspecies

Holotype.—Female from Swamp Pond, Craven County, N C., U.S.N.M. no. 79249. Collected by Paul McKee, January 16, 1938. Males have not been found. (McKee and Coker, 1940.)

Diagnosis—Second foot conforming to the type; vestigial seta of fifth foot rather long—about one-sixth the length of outermost seta; relative lengths of spines on that segment about as in *C. staphylinoides;* anal spines small, 10 to 12 in number; many small spinules just lateral to the straight mesial borders of furcal rami on ventral side. (Now known only from waters of the lower Coastal Plain in North Carolina)

Description.—Second foot: The endopod has only one seta on the inner border of the third segment (Fig. 1, *c*) where *sinuus* has two (Fig. 1, *j*); apparently it is the distal seta that is lacking. Pearse did not describe or figure this foot, but copepods we have from Massachusetts seem to agree in every other particular with the description of *C. staphylinoides* and are found to have only one seta in the place mentioned.

Fifth foot: Examples from Baker Lake have a distal joint of the fifth foot virtually identical with that of *C. sinuus*, but the short seta between the bases of the outermost setae of the proximal segment is distinctly longer than the corresponding seta of *sinuus* or of *staphylinoides* from Massachusetts (compare Figs. 1, *e*, and 1, *a*, with Figs 1, *k*, and 1, *g*). The third well-developed seta, counting from the outer border of this segment, is distinctly shorter than the fourth, whereas in *C. sinuus* (Fig. 1, *k*) the two are approximately equal; in this respect the copepods in question are like *C. staphylinoides* (Fig. 1, *g*). The copepods from Swamp Pond (Fig. 1, *a*) have all spines, except perhaps the two outermost setae and the innermost seta of the distal joint, decidedly shorter, blunter, and stronger. The short seta of the proximal segment is intermediate between that of Baker Lake and *C. sinuus*, but its length, relative to that of the longest spine, conforms roughly with the corresponding relation in the Baker Lake copepods. This is true also of the third well-developed spine.

Caudal furca: The form of the furca (Figs. 1, *b*, *f*) is quite unlike that characteristic of *C. sinuus* (Fig. 1, *i*) but like that of *C. staphylinoides* (Figs. 1, *l*, *h*). On each branch of the furca there is a submarginal row of fine spinules or setae on the ventral surface a little lateral to the inner margin (Figs. 1, *b*, *f*); these spinules are not well seen until the furca is turned at an angle,

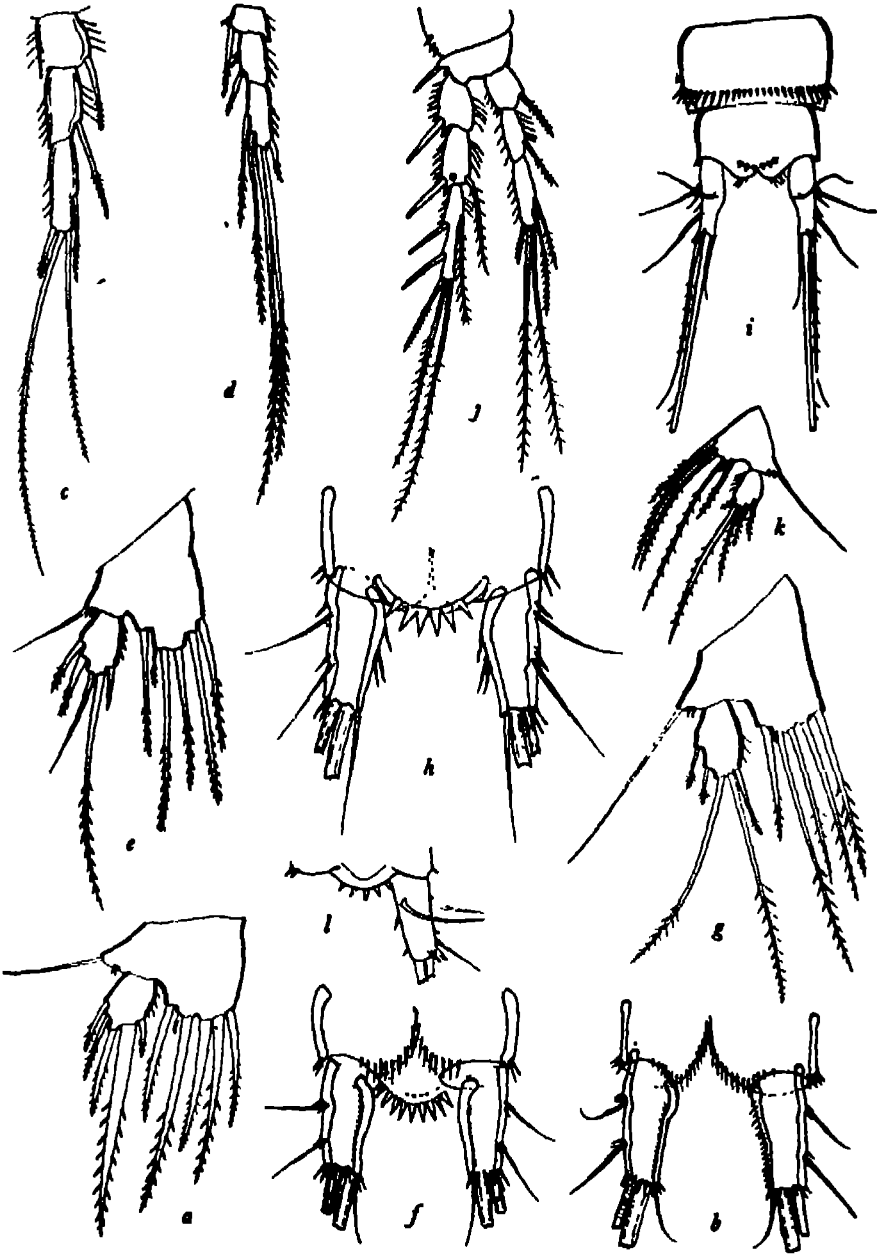

Fig. 1.—*Canthocamptus staphylinoides vagus*, holotype, female, from Swamp Pond: *a*, Fifth foot; *b*, furca—ventral aspect, slightly turned. *Canthocamptus staphylinoides vagus* from Baker Lake: *c*, Endopod of second foot, female; *d*, endopod of third foot, female; *e*, fifth foot; *f*, furca. *Canthocamptus staphylinoides* (s. str.) from Massachusetts: *g*, Fifth foot; *h*, furca—dorsal. *Canthocamptus staphylinoides* (after Pearse, 1905): *i*, Furca. *Canthocamptus sinuus* (from Coker, 1934): *j*, Second foot, female; *k*, Fifth foot; *l*, furca.

as shown in Fig. 1, *b*. The furca of the Massachusetts copepod (Fig. 1, *l*) seems to be typical of *C. staphylinoides* as described and illustrated by Pearse (Fig. 1, *h*), with a few rather strong setae showing on the inner margin or ventrally.

Anal plate: The spinules of the anal plate (Figs. 1, *b*, *f*) are relatively small, there being 10 on the examples from Baker Lake, 12 on those from Swamp Pond. The number in *C. sinuus* (Fig. 1, *i*) and *C. staphylinoides* (Fig. 1, *h*) is about 6, and the spinules are distinctly stouter.

The differences between the copepods from Baker Lake and those from Swamp Pond are insignificant. In respect to the fifth foot, the differences between these copepods on the one hand and either *C. staphylinoides* or *C. sinuus* are also inconsiderable.

Remarks.—Comparison of the new copepod with the previously described forms is given in the following table, where the mark "X" is used when the character is common to two, and the mark "—" where a distinctive character is found.

Species	Second foot	Rudimentary seta	Fifth[1] foot	Anal spines	Furca form	Armature
C staphylinoides	X	X	X	X	X	—
C. s vagus n subsp	X	—	X	—	X	—
C sinuus	—	X	—	X	—	—

[1] Relative lengths of seta on first segment.

Since *C. sinuus* may now be presumed to differ from *C. staphylinoides*, not only in the form and armature of the furca, but also, and significantly, in the armature of the second foot, it should be regarded as a distinct species. The furca is unmistakable at a glance.

For direct comparison with the foregoing diagnosis of *C. s. vagus* we present here diagnoses of *C. staphylinoides* Pearse and *C. sinuus* Coker (here raised to the status of a species; described by Coker, 1934), the only other members of the restricted genus *Canthocamptus*, as defined by Chappuis and followed by the senior author in *Contribution to knowledge of North American freshwater harpacticoid copepod Crustacea*, 1934, now known to occur in the United States.

C. staphylinoides Pearse: Characters of the genus (both rami of second to fourth swimming feet 3-jointed, a vestigial seta on mesial expansion of fifth foot, etc.); second foot with one seta on inner border of third segment of endopod; short seta between bases of two outermost setae of proximal segment of P5 very short—about one-twelfth as long as the adjacent outermost seta or shorter; third well-developed seta of that segment, counting from the outermost border, shorter than fourth; anal spines large, 6 to 8 in number; a few prominent spinules on the straight mesial side of each furcal rami. (Now known only from Northern United States and Canada.)

C. sinuus Coker: Second foot with two setae on inner border of third segment of endopod; vestigial seta of P5 about as in *C. staphylinoides*; third well-developed seta on that segment about equal to fourth; anal spines 6 to 8 in number; mesial profile of furcal rami *sinuous* and *unarmed*. (Known from Connecticut, New Jersey, and North Carolina.)

Our new copepod is nearer to *C. staphylinoides* than to *C. sinuus* in the second foot, the fifth foot, and both the form and armature of the furca, although it differs from the former in the rudimentary seta of the fifth foot, the anal spines, and the armature of the furca. Since, however, the differences between our copepod and *C. staphylinoides* are quantitative and may be presumed to be subject to considerable variation, I would propose only a new subspecific name *vagus*, referring to its apparent habit of wandering out into open water. Harpacticoid copepods are characteristically littoral in the extreme and it is worthy of note that this copepod was taken repeatedly in plankton hauls during a survey covering 45 waters. The only other harpacticoid encountered was *C. sinuus* in one collection from a shallow swamp lake.

Some of the older lists of American harpacticoid copepods include *C. staphylinus* Jurine, but it is very probable that the records of the European species, which is clearly distinguishable by the conspicuous blunt, spinelike projection on the posterolateral margins of the fifth abdominal segment, as well as by other characters, are attributable to errors in identification. We know of one such case.

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PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

PHILOSOPHICAL SOCIETY

1155TH MEETING

The 1155th meeting was held in the Cosmos Club Auditorium, Saturday, October 14, 1939, President Brickwedde presiding.

Program: T. F. W. Barth, Geophysical Laboratory: *Geysers and other hotsprings in Iceland.*—The thermal activity in Iceland, which is but one phase of the recent volcanicity, is not equaled in intensity or extent by any other region. Pioneers of our modern science, men like Bunsen, Descloizeaux, and others, visited Iceland to study these phenomena, and through their work the local name of the most famous spouting fountain in Iceland at that time, viz., "Geysir" (meaning "spouter") was accepted as a general term for hotsprings of this type.

The acid springs are intimately associated with recent volcanic activity, the alkaline springs are more independent in this respect, but are clearly most plentiful in areas possessing a superior water supply. Both acid and alkaline springs may show geyser action. Some of the geysers form deep wells, but measurements show that, although the temperature increases with depth, the boiling point is not reached at any depth—this is also true for the Great Geysir, which is 27 m deep.

The biggest boiling stream in the world is a copious spring in western Iceland the discharge of which is nearly 300 liters per second. The thermal energy it carries with it is approximately 140,000 horsepower. (*Author's abstract.*)

A. NADAI, Westinghouse Electric and Manufacturing Co.: *Formation of surfaces of slip under plastic states of stress.*—A characteristic phenomenon accompanying the plastic deformations of natural rock materials or of the ductile metals is the formation of very regular markings on the surface of test specimens. They are the traces of deformations localised in thin layers of the material which become plastic under the given system of forces. The laws of the formation of these slip layers are not yet fully understood and are rather intricate. Several important factors are required to be satisfied for the localised yielding of materials, which were discussed. Formation of regular spirals around a punch mark was shown for mild steel. Similar lines seem to mark the location of secondary cones on certain volcanoes in Japan. The formation of faults in geology seems to follow similar laws than the one describing slip in metallic materials. A motion picture was shown on the formation of gliding lines in mild steel bars. (*Author's abstract.*)

The first paper was discussed by Messrs. WRIGHT and GISH; the second one by Messrs. HAWKESWORTH, GISH, ROLLER, MAXWELL, and BRICKWEDDE.

1156TH MEETING

The 1156th meeting was held in the Cosmos Club Auditorium, Saturday, October 28, 1939, President BRICKWEDDE presiding.

Program: K. H. BEIJ: *Model testing at the National Hydraulic Laboratory.*—The National Hydraulic Laboratory is authorised to conduct general research in hydraulics on problems of its own choice and to work on specific engineering problems at the request of other Government organizations. For obvious reasons ship-model work is excluded, and for practical reasons pump and turbine testing is not feasible at the present time. The general study of the theoretical bases underlying hydraulic model studies is an important field of research that has not received sufficient attention. It appears likely that the laboratory will enter this field in the near future. Model tests for specific purposes have been conducted for and with the cooperation of several Government departments. The purposes of such model tests are (1) to check calculations of design, (2) to suggest improvements either to assure better performance or to lower costs without material sacrifice in performance, and (3) to discover and correct undesirable or even dangerous conditions which could not have been foreseen in the design. Lantern slides were shown illustrating representative model tests, and some of the problems encountered in making these studies were discussed. These problems include on the one hand, the construction, operation, and instrumentation of models, and on the other hand, the difficulties and uncertainties arising from the impossibility of obtaining strict similarity of model to prototype. (*Author's abstract.*)

H. E. SAUNDERS, U. S. Navy: *The David W. Taylor Model Basin at Carderock, Md.*—The completion of the buildings for the new ship model testing establishment of the United States Navy at Carderock, Md., just northwest of Washington, has already received considerable publicity in the press. These buildings have a function much different from that of the multitude of new public buildings erected throughout the country in the last decade. Pictorially they are of great interest to the public because of the simplicity and dignity of their architecture and the use of precast exposed aggregate concrete for the exterior finish. The large building housing the model basins, with its arch roof, is a quarter of a mile long and is the only one of its type in the United States.

The new establishment has been named the David W. Taylor Model Basin in honor of Rear Admiral David W. Taylor, Construction Corps, U. S. Navy (Retired), whose researches in ship propulsion and whose experiments with ship models have made his name renowned throughout the world.

The model testing plant at Carderock includes four separate model basins, each of which is designed to undertake and prosecute to the best advantage a particular kind of ship model research. These four basins will, in addition, provide a plant of vastly increased capacity for undertaking a steadily increasing volume of work. The old model basin at the Washington Navy Yard, built in 1899, is now running sixteen hours a day in an endeavor to keep pace with the requirements of the current naval and merchant ship program. The ship-model basins at Washington are the only ones in America equipped to undertake tests of ship models when they are driven by their own propellers. They perform towing tests and self-propelled tests of this kind for private shipbuilders and naval architects of the United States as well as for the Navy Department and all other Government departments.

To enable the staff to make correct predictions of ship performances to within a few percent, as modern designs require, the new basins at Carderock, embody a number of distinctly novel features. To obtain the desired accuracy for model tests, the carriages that tow the ship models through the basins must run at constant speed on tracks that are straight and level within a few thousandths of an inch.

The walls of the basins upon which these tracks rest are of massive concrete construction, built directly upon bed rock. The track structure is of a new design, using a rail heavier than that employed on any railroad in the world and a rail supporting structure which is much more rigid than that in any other model basin track. As it is expected that at least a year will be required to lay the carriage tracks to the requisite degree of accuracy, it is intended by this means to provide a permanent track structure which will require no further attention for many years to come.

The work of laying the tracks alongside the new model basins is now being undertaken by the staff of the David W. Taylor Model Basin and they hope that by the summer of 1940 the work of ship model testing in the new plant will have begun. (*Author's abstract.*)

The second paper was discussed by Messrs. LIFEROCK and PAWLING.

1157TH MEETING

The 1157th meeting was held in the Cosmos Club Auditorium, Saturday, November 11, 1939, President BRICKWEDDE presiding.

Program: L. V. BERKNER: *Fluctuations in the earth's outer atmosphere during a great magnetic storm.*—The great magnetic disturbance that occurred on April 16, 1938, was one of the largest in recent years. Records of ionospheric changes on the magnetic equator at Huancayo, Peru, are complete during this disturbance. Actual distribution of ion-density at successive quarter-hourly intervals can be represented by parabolic distributions which would produce the observed records using a method recently described by Booker and Seaton.

With advent of the storm, just after midnight, maximum electron density of the F-region (above 250 km) fell in the first hour by three orders of magnitude and essentially to zero, with the disturbance progressing downward through the ionosphere. Then appeared an intensely ionized absorbing region at 85 km (near where maximum conductivity per electron is experienced) which is shown to have covered a substantial portion of the earth's surface. The disturbance then progressed rapidly upward with the height of F-region apparently rising at about 8 km per second first with increasing and then decreasing ion-density until there remained a maximum density of only 5,000 electrons per cc in the neighborhood of 1,000 km. Recovery came with daylight.

A number of interesting problems are raised in view of the restrictive influence of the earth's magnetic field on motions of charged particles at the magnetic equator. Possibly the ionosphere above Huancayo might be imagined to explode toward the polar regions during the disturbance. Mechanism of entrance of the disturbing influence from the sun which produced the effect offers room for speculation. (*Author's abstract.*)

ELLIS A. JOHNSON: *Scattering of light from a modulated searchlight beam at high altitudes.*—The measurement of the light scattered by the atmosphere from an intense searchlight beam up to heights of 34 km was described. The method makes it possible to determine the temperature and pressure with height above the earth's surface and to make determinations of some of the atmospheric constituents. The experimental procedure consists in directing an intense searchlight beam nearly vertical and modulating it at 10 cycles per second with Venetian blind shutters. A receiver, consisting of a large mirror with a photoelectric cell at its focus, is placed about 6 km away. The beam can be scanned by tilting the receiver and the height at any particular angle calculated from the geometry. The sensitivity is limited by the background statistical fluctuation of shot-effect due to photocell current caused by light from the night sky. Measurements above a low haze bank agreed with the atmosphere given by Humphreys up to 34 km. With 60-inch mirrors at the receiver and transmitter, it is calculated that heights of 80 km could be reached, and problems such as the distribution of ozone, water vapor, turbulence, winds, dust, fluorescence, etc., could be studied. (*Author's abstract.*)

The first paper was discussed by Messrs. SEEGER, GOLDBERG, BITTENGER, MOHLER, BRICKWEDDE, S. S. HURLEY, HOWE, McNISH, and SMITH; the second paper by Mr. BRICKWEDDE.

J. PAWLING presented an informal communication, which was a report of progress on *The new general catalog of Albany.*

1158TH MEETING

The 1158th meeting was held in the Cosmos Club Auditorium, Saturday, November 25, 1939, President BRICKWEDDE presiding.

Program: J. C. HUBBARD, Johns Hopkins University: *Ultrasonics and the ratio of specific heats of gases.*—Among the indirect methods of studying the specific heats of gases, those involving measurements of sound velocity have been considered most ideal. However, until the advent of ultrasonics, values obtained by acoustic methods have been disappointing, in spite of a vast amount of empirical and theoretical work on corrections entailed by the confinement of sound waves within a chamber necessarily of dimensions of the same order of magnitude as the wavelength. Ultrasonics provides wave lengths measured in millimeters or less, and experiments with them are comparable to experiments with ordinary sound waves in chambers so large as to eliminate the boundary corrections. The way is thus opened to a study of various gases; moreover these need be used only in small amounts. The results are of a highly satisfactory precision and yield satisfactory values of specific heats except insofar as they are influenced by the dynamic character of sound waves. In many cases it is found that there is a lag in the adjustment of certain energy states of the molecule. This effect was responsible for ultrasonic dispersion found in CO_2 in 1925 by G. W. Pierce and accounted for theoretically in 1928 by Herzfeld and Rice. Ultrasonic methods have now been developed so that precise acoustic data on specific heats may be secured over a very great range of temperatures and pressures. The character of the results permits the detection of those regions of pressure or frequency in which energy lags are present, and are thus useful in determining lifetimes of energy states Examples were shown. (*Author's abstract.*)

FRANCIS E. FOX, Catholic University of America: *Supersonics in liquids.*—For the production of ultrasonic waves in liquids the source is usually a magnetostrictive rod or piezo-electric quartz plate with its vibration electrically maintained and coupled by direct contact with the liquid. The investigation of the waves, and through them of acoustic properties of the liquid, may be carried out by electrical, mechanical, or optical effects produced by the waves.

(1) The reaction upon the driving electrical circuits produced by waves reflected back to the source, as in the acoustic interferometer, may be expressed as functions of the reflector distance and the half-wavelength in the medium, the absorption factor, and the coefficient of reflection. (2) The steady radiation pressure exerted on an obstacle in the sound field offers a direct means of investigating the intensity. (3) The variations in the index of optical refraction that are produced by the sound wave have been the basis of many optical methods. (*a*) in the Sears-Debye method one uses the sound beam as an optical grating. Progressive or stationary waves may be used. (*b*) With Schlieren methods, of which there are many variations one renders the stationary sound fields visible with constant illumination, or employs stroboscopic light to investigate progressive waves. (*c*) The diffraction-interference methods enable one to 'see' the sound field in the liquid.

The choice of a method depends of course on the problem to be investigated. Methods that permit accurate determination of wavelength may yield little information about intensity or absorption. It may be possible to extend the range of frequency in which some one method is applicable by combining that method with a different one, e.g., the acoustic interferometer with an optical indicator or resonance for very short wavelengths.

The demonstration included the acoustic interferometer, radiation pressure, and several optical effects. (*Author's abstract.*)

The first paper was discussed by Messrs. H. L. CURTIS, HERZFELD, and BRICKWEDDE; the second one by Messrs. BRICKWEDDE, LEWIS, and others.

1159TH MEETING

The 1159th meeting, constituting the 69th annual meeting, was held in the Cosmos Club Auditorium, Saturday, December 9, 1939, President BRICKWEDDE presiding.

The treasurer reported that the income from dues, interest on investments, and sale of reprints was $1,392.94 and that the expenditures exclusive of investments was $1,342.46, leaving a net surplus of $50.48 on ordinary expenses. The ordinary expenditures were at the rate of $4.18 per member.

The secretaries' joint report showed an active membership as of December 1, 1939, of 321, of whom the following were elected during the year: John Beek, Jr., Paul Bradt, Brice A. Brooks, L. O. Colbert, Richard M. Fraps, Chas. K. Green, Ralph F. Haupt, Albert J. Hoskinson, Henri Jordan, J. W. Joyce, Thoburn C. Lyon, Harold W. Murray, F. W. Reichelderfer, C.-G. Rossby, W. H. Seaquist, Douglas R. Tate, W. A. Wildhack, and Walter J. Young. The following were elected in 1938 and qualified in 1939: L. Leon Shereshefsky and H. M. O'Bryan.

The following death was reported: James H. Gore.

The following officers were declared elected for the year 1940: *President*, R. E. Gibson; *Vice-Presidents*, H. E. McComb and W. G. Brombacher; *Corresponding Secretary*, H. F. Stimson; *Treasurer*, W. E. Deming; *Members-at-Large of the General Committee*, L. V. Berkner and R. W. Curtis.

Program: G. Gamow: *Uncertainties in atomic and common life.*—In classical physics, the notions of the trajectory, position, and velocity of a moving object were always considered as given *a priori* and self-evident. However, the discovery of the quantum-phenomena leads to a conclusion that these seemingly fundamental notions represent actually only very good approximations to quite different and rather involved basic principles of a correct system of mechanics.

Analyzing the method by which an idea of trajectory, for example, could be constructed, we find that this cannot be done if the physical action can be delivered only in the form of certain finite portions or quanta. This criticism leads to fundamental uncertainty in the description of physical phenomena, expressed in the so-called Heisenberg's uncertainty relations between the coordinates and mechanical momenta of moving particles. It can be shown that the product of the uncertainties of these two quantities is equal to the basic quantum constant, so that if the position is known very accurately, the momentum is not, and vice versa.

Analogous relation exists between the energy and time, which, according to the theory of relativity, represents the fourth pair of data describing the event in the four-dimensional time-space. The possible methods for simultaneous measurement of energy and time have been discussed by N. Bohr who has shown that such measurements necessitate taking into account the effects of general relativity. Making use of Einstein's "red-shift-formula," Bohr proved that the uncertainty relation between energy and time must hold in any such measurement.

It is usually believed that owing to extremely small value of the quantum-constant, uncertainty phenomena can be of importance only in the atomic world. It is, however, not so. If, for example, we fix a steel ball 1 inch in diameter rigidly on the table and drop another ball of the same size from the point several feet above the fixed ball, classical mechanics will tell us that our ball will jump up and down until the energy will be dissipated by friction. According to quantum-mechanics, however, the existing uncertainty of the position and momentum of the ball at the moment it is dropped, will cause a quite appreciable deviation and will make the ball drop aside after only a few jumps. Unfortunately no technically produced steel is homogeneous enough to permit such experimentation.

We can imagine, however, some crazy worlds in which the quantum-constant is so large that the uncertainty relations could be observed microscopically. One fellow, called Mr. Tompkins, used to dream about such worlds and had a lot of very unusual experiences in them. Not only was he unable to play a good billiard game with "spreading-out" quantum balls, but also his car ran out of the garage leaving through the wall just as an α particle from the atomic nucleus. Going to hunt tigers, he was quite scared to see a tremendous number of tigers jumping on his elephant simultaneously from all sides. He explained, however, that there was only one tiger in the first quantum state around the elephant, and the tiger was soon shot by a quantum bullet. Mr. Tompkins awoke after that event, but forever after remembered what the uncertainty-relations actually are. (*Author's abstract.*)

This paper was discussed by Messrs. O'BRYAN and BRICKWEDDE.

1160TH MEETING

The 1160th meeting was held in the Cosmos Club Auditorium, Saturday, January 6, 1940, President GIBSON presiding.

The Retiring President, F. G. BRICKWEDDE, gave an address entitled *Some complexities of the simple element hydrogen.* It is expected that this address will be published in this JOURNAL.

1161ST MEETING

The 1161st meeting was held in the Cosmos Club Auditorium, Saturday, January 20, 1940, President GIBSON presiding.

Program: F. S. BRACKETT: *Spectroscopic methods and their importance in biological research.*—When radiation produces a measurable change, be it physical, chemical, or biological, the plot of wavelength dependence of the measured change may be termed an "action spectrum." In biophysics action spectra are fully as important as emission and absorption spectra. Familiar examples: In physics, the wavelength dependence of photocell sensitivity; in chemistry, the photochemical yield as a function of wavelength; and in biology, the visibility curve of the eye.

The photochemical problem is simpler than the biophysical, since the absorption spectrum of the absorbing molecules may be measured and the concentrations of the components of the system varied in order to determine the kinetics of the system. Here the purpose of the action spectrum is to establish the photochemical threshold and the quantum efficiency. In biophysics, even the absorbing molecule may be unknown. The purpose of the action spectrum may therefore be to determine the effective absorption spectrum and the efficiency or number of quanta required to produce the effect. A common form of biophysical action spectrum is the wavelength plot of the reciprocal of the incident energy required to produce an equal biological change. Typical example—the lethal action of radiation on microorganisms. Assuming Beer's law a general expression is deduced which leads to simple interpretation in two important cases. One, where the population of microorganisms in suspension is small, that is, less than ten percent of the beam absorbed. Here it is shown that the action spectrum yields the wavelength dependence of the product of efficiency and absorption coefficient per organism. The second case is where the number of organisms in suspension is large, so that practically all energy is absorbed. Here the action spectrum yields directly the efficiency or the reciprocal of the number of quanta required to kill the organism.

The requirements on spectrographic equipment for obtaining action spectra are fundamentally different from those to obtain emission or absorption spectra. In general an output of great radiant power is necessary in order to produce a measurable change in a reasonable length of time, but high intensity is not necessary. High purity, that is, freedom from scattered radiation is required though high resolving power is not. This leads to instruments with a large linear aperture but not necessarily large relative aperture; high dispersion but low resolving power. For this purpose, large quartz prisms are ideal in the ultraviolet, the number of prisms being as great as is compatible with maintenance of high transmission. Gratings are preferable in the visible. Slit widths may be wide, but a double monochromator to eliminate scattered radiation is often necessary. (*Author's abstract.*)

P. A. COLE, National Institute of Health: *Determination of cell structure by means of the ultraviolet microscope.*—A brief summary of the historical development of the ultraviolet microscope was given. An eventual goal of all previous workers has seemed to be to attain ultraviolet absorption spectra of microscopic objects. The difficulties encountered in attaining this goal were discussed. Preliminary photographs were shown taken at various ultraviolet wavelengths and a method was described by which the absorption spectrum of a portion of a microscopic organism could be determined. (*Author's abstract.*)

The first paper was discussed by Mr. O'BRYAN; the second one by Messrs. GIBSON, BRACKETT, BRIGGS, TELLER, HUMPHREYS, H. L. CURTIS, F. COE, and others.

1162D MEETING

The 1162d meeting was held in the Cosmos Club Auditorium, Saturday, February 3, 1940, President GIBSON presiding.

Program: P. A. SMITH: *Exploring the continental shelves and slopes.*—Knowledge of the topography of the sea floor has grown rapidly during the past decade, largely through the development of echo-sounding. Owing to the accompanying need for more complete nautical charts, several of the maritime nations have extended hydrographic surveys seaward from their shores; and due to this seaward extension of the surveys a whole new physiographic realm is being opened to students of earth science. The perfection and use of offshore position finding methods and echo sounding by the U. S. Coast and Geodetic Survey has added many thousands of square miles of surveys of the continental shelves and slopes of United States and waters under their jurisdiction. The discovery of the stream-erosion type of topography on the seaward faces of the continental shelves under hundreds of fathoms of water has raised questions that seriously affect a number of cherished geological theories. While topographic characteristics of numerous submarine canyons are clearly and unmistakably those commonly observed in valleys eroded by running water above the sea, many geologists have felt that the simple explanation of a lowered sea or rising land in the order of 10,000 feet and back in late Tertiary or Pleistocene time is untenable in the face of apparently well-established theories. A number of hypotheses have been advanced in the attempt to explain these features by some process that may harmonize with other geologic evidence, but the origin of submarine canyons is still controversial.

Through a number of contributors, including Dr. H. S. Stetson of the Woods Hole Oceanographic Institution, Dr. Maurice Ewing of Lehigh University, and collaborators, and Dr. C. S. Piggot of the Geophysical Laboratory, Carnegie Institution, our knowledge of the materials and underlying strata of the sea floor is being expanded. In all this work the Geological Society of America has been especially interested, and has contributed greatly to the growth of knowledge in this field of science through grants to various investigators.

Automatically recorded profiles of submarine topography of the Atlantic Continental Slope show decidedly V-shaped cross sections, in the extreme heads of the canyons as well as in depths of 6,000 feet and over. Due to certain limitations of echo sounding it is sometimes impossible to record the bottom of steep, narrow ravines in deep water, or to record true slopes in very rugged topography. Graphic records of echo sounding always give a more complete picture of the profile than visual indicators and in many instances reveal phenomena that might otherwise be missed, such as the great sand waves found south of Nantucket Island during the summer of 1939 by the Coast and Geodetic Survey Ship *Oceanographer*.

The abrupt change from the topography of the shelf which is plainly marine made in character, to that of the slope which shows no indications of marine erosion, but is plainly that commonly attributed to stream erosion is one of the most remarkable of the many interesting facts demonstrated by the new surveys. The cooperation of the Geological Society of America through the late Dr. A. C. Veatch and the Coast and Geodetic Survey has resulted in the publication of these new surveys in the form of special charts for use by various investigators. (*Author's abstract.*)

T. C. LYON, U. S. Coast and Geodetic Survey: *Methods of air navigation and aeronautical charts.*—Air transportation is still making rapid strides, and the distribution of aeronautical charts by the Coast and Geodetic Survey during the past year exceeded the distribution of nautical charts.

The basic methods of marine navigation are also the basic methods of air navigation, although new instruments and stream-lined technique are required for the higher speeds of aircraft.

Aeronautical charts are comparable to nautical charts. They differ from topographic maps in their emphasis upon landmarks, in the degree of accuracy required, and in the necessity for frequent revisions.

Three standard series of aeronautical charts are now being published by the Survey: 87 sectional charts, scale 1:500,000; 17 regional charts at 1:1,000,000; and 6 direction finding charts at 1:2,000,000—all on the Lambert conformal conic projection. These are designed to meet the needs of aircraft of widely different speeds and methods of navigation.

Aeranautical charts are compiled from the best available data, and checked from the air before distribution. For the future, air navigation will be at new altitudes, with new methods, new instruments, and possibly new charts, in prospect.

Specimens of the standard charts, and also of several experimental charts, were on display. (*Author's abstract.*)

The first paper was discussed by Messrs. EATON, PAWLING, and HUMPHREYS.

1163D MEETING

The 1163d meeting was held in the Cosmos Club Auditorium, Saturday, February 17, 1940, President GIBSON presiding.

Program: H. R. MORGAN, U. S. Naval Observatory: *The motions of the earth.*—Observations of the sun, moon, and planets in the past 300 years show rather large and irregular deviations from their gravitational orbits. These are attributed to fluctuations in the rate of rotation of the earth giving a variable time amounting to as much as 60 seconds of time in a century as compared with a perfectly uniform time.

To determine the motions of the planets over long periods of time it is necessary to have a uniform time unit. The new tables of the moon are so accurate they may be used for this. In an investigation of the motion of the planet Mercury, now being carried on at the Naval Observatory, the observed deviations of the moon from its gravitational orbit are used as the corrections to variable earth time to reduce it to uniform or Newtonian time. (*Author's abstract.*)

C. B. WATTS: *A traveling-wire micrometer with photographic registration.*—The 6-inch transit circle of the U. S. Naval Observatory has been equipped with a photographic register for use with the traveling-wire micrometer. The usual method of recording on a chronograph the signals originated by a contact device on the micrometer has been discarded. It is replaced by a system in which a portion of the graduated head of the screw is photographed periodically on recording paper while a transit is being observed. The exposures are initiated by the clock and no chronograph is required. The result is equivalent to that yielded by the older method; there are, however, several advantages in the new system. One of these is the fact that the position of the traveling wire is recorded at the same time intervals for all declinations. These intervals are sufficiently great to insure the independence of successive recordings; closely spaced signals for an equatorial object and excessively long intervals for a circumpolar star are both avoided. The new device also serves as an efficient recorder of pointings made on the collimators, meridian marks, and reflected nadir images. When used for this purpose the exposures are initiated by the observer. (*Author's abstract*)

The first paper was discussed by Messrs. MEGGERS and WATTS; the second by H. L. CURTIS.

F. G. BRICKWEDDE gave an informal communication on a new temperature scale that has been proposed. He showed by a quotation from a paper by J. P. Joule and William Thomson entitled *On the thermal effect of fluids in motion*, which appeared in Phil. Trans. **144**: 32 (1854), that the idea was original with them. This was discussed by Messrs GIBSON and TUCKERMAN

1164TH MEETING

The 1164th meeting was held in the Cosmos Club Auditorium, Saturday, March 2, 1940, President GIBSON presiding.

Program: A. H. PFUND, Johns Hopkins University: *A partial analysis of gaseous mixtures without the use of a spectroscope.*—This procedure is based on the fact that certain gases and vapors such as CO_2, H_2O, CH_4, etc. have absorption bands in characteristic wave-length regions in the infrared spectrum. The apparatus consists of an incandescent solid whose radiations pass through an initially evacuated absorption-cell and then enter a detector containing a gas such as CO_2. Some of this radiation will be absorbed and transformed into heat, thus raising the temperature of the gas and affecting thermo-junctions not in the direct path of the radiation. Upon admitting air containing CO_2 into the absorption-cell, this CO_2 prematurely removes or weakens those radiations which, previously, had heated the CO_2 in the detector. As a result, the temperature of the gas in the detector drops.

Applications of this procedure to ventilation, fermentation, and respiration were discussed. (*Author's abstract.*)

A. G. MCNISH: *The geomagnetic field and its variations.*—The general magnetic field of the earth may be represented to within the reliability of the observations by a dipole near the center (moment 8×10^{25} cgs units), giving rise to about 80 percent of the field, and 14 secondary radially directed dipoles (average moment 0.1×10^{25} cgs units) located at specified positions midway between the surface of the earth and its center, giving rise to the remainder or residual field.

Secular change can be represented by the yearly addition of 13 dipoles of equal strength (moment 1.4×10^{22} cgs units) at the same depth as the dipoles of the residual field. Continuance of secular change at the present rate for one hundred years would thus build up a new residual field.

Interpretation of this model leads to the beliefs that (1) at least a considerable portion of the earth's magnetism (the residual field) originates at a lesser depth than the central core revealed by seismological evidence, and (2) secular change involves this residual field and therefore is due to changes taking place between the surface of the earth and the surface of the central core. (*Author's abstract.*)

The first paper was discussed by Messrs. Gibson, Maxwell, Brickwedde, Karrer, Mueller, McNish, Humphreys, and Astin; the second one by Messrs. Gibson, Seeger, Teller, McComb, Smith, Brickwedde, and Howe.

1165th MEETING

The 1165th meeting was held at the Cosmos Club Auditorium, Saturday, March 16, 1940, President Gibson presiding.

The Tenth Joseph Henry Lecture entitled *Differences in physical properties of isotopes* was delivered by Prof. Harold C. Urey, of Columbia University. This lecture has been published in this Journal **30**: 277–294, 1940.

1166th MEETING

The 1166th meeting was held in the Cosmos Club Auditorium, Saturday, March 30, 1940, President Gibson presiding.

Program: R. M Zabel, Hygrade Sylvania Corporation: *Fundamentals of fluorescence.*—Since Edison's invention of the incandescent lamp in 1879, incandescent lamp efficiencies have increased from slightly over 1 lumen per watt to 14 lumens per watt for a standard 60 watt tungsten lamp. The introduction of the fluorescent lamp has increased this efficiency to approximately 42 lumens per watt (including lamp wattage and auxiliary loss).

The visible light in a fluorescent lamp is generated by the passage of a discharge through a mixture of argon gas and mercury vapor, the discharge being operated under such conditions that as high a percentage as possible of the radiation generated is in the resonance line of mercury (2537 Å). This ultraviolet radiation is absorbed by the fluorescent material on the inside of the lamp and re-radiated as visible light of a wavelength depending upon the type of fluorescent material used.

The effect of small quantities of foreign materials upon the fluorescent and phosphorescent characteristics of a silicate or tungstate, such as is most commonly used in fluorescent lamps, is very marked. For example, the introduction of 1 percent manganese in zinc silicate greatly increases the fluorescent output and moves the maximum of the output curve from approximately 4,150 Å to 5,230 Å. On the other hand, the introduction of iron, copper, or nickel greatly decreases the fluorescent output. This effect is presumably due to the introduction of additional energy levels in the fluorescent material due to the replacement of the normal metallic constituents of the crystal by the foreign metallic elements. In some cases these additional energy levels are properly placed to radiate light in the visible region. In other cases, they may be so placed as to re-radiate the light outside the visible, generally in the infrared. This, of course, wastes the energy.

Phosphorescence differs from fluorescence in that a time lag exists before the light output of the phosphor builds up to a maximum and also a lag exists in the decline of the light output to zero after the starting or stopping of the exciting radiation. Many fluorescent materials exhibit both fluorescence and phosphorescence. Phosphorescence in the type of materials under consideration is ascribed to the presence of potential traps which hold appreciable quantities of electrons which escape slowly through the barrier of the trap before returning to their normal place in the crystal structure and emitting the radiation normally coincident with this energy interchange.

Various fluorescent materials are mixed to obtain the color desired in a finished fluorescent lamp.

The quantum efficiency of the best fluorescent material found to date is approximately 70 percent. (*Author's abstract.*)

W. P. LOWELL, JR., Hygrade Sylvania Corporation: *Practical application of fluorescent lighting.*—To use fluorescence in practical lighting it is necessary to combine a source of ultraviolet and the proper phosphor in a convenient form, and to devise means of operating this lamp on the 115-volt 60-cycle circuits generally available in this country. The lamps which have been developed are long tubes having electrodes at both ends, powdered phosphor on the inner surface of the tube, and a filling of mercury vapor and rare gas at low pressure.

The electrical control circuit consists of inductive ballast in series with the lamp, to control the current, and an automatic switch to aid in starting the lamp. This switch provides for preheating of the cathodes, then applies sufficient voltage across the tube to insure starting the arc. Several types of starting switches were demonstrated, including Manual, Magnetic, Thermal, "Glow Tube," and High Resistance Thermal.

The power factor of this lamp and inductive ballast being inherently low (and lagging) it is our practice to ballast alternate lamps with a combination of capacitance and inductance, thus operating one lamp with leading current, and the resultant power factor of each pair of lamps very near to unity

Practical lighting units, each one complete with lamps, ballasts, starters and all necessary reflectors and glass diffusers were demonstrated, including the illumination of one-half the lecture hall with two of the "Miralume" units. Lantern slides were shown of many actual installations of fluorescent lighting.

In conclusion, the effect of Daylight Fluorescent color was demonstrated on flowers and many other objects. The ordinary tungsten filament incandescent lamp is, of course, far more yellow and red than natural daylight, while the Daylight Fluorescent Lamp is very close to actual average daylight (color temperature 6,500° K.). Blue flowers and blue cloth are particularly striking when their true color under Daylight Fluorescent is compared to identical samples under an incandescent source. (*Author's abstract.*)

1167TH MEETING

The 1167th meeting was held in the Cosmos Club Auditorium, Saturday, April 13, 1940, Vice-President MCCOMB presiding.

Program: L. MARTON, R. C. A. Manufacturing Co.: *Electron microscopy.*—The discovery of the optical behavior of electron beams led to the development of a new branch of science: "Electron microscopy." It is based on the analogous use of light optical elements in a compound light microscope and electron optical elements in an electron microscope; and on the highly increased resolving power due to the much shorter wavelength of electrons.

On considerations of wavelength alone, an enormous increase in resolving power should be obtainable. However, this is limited by a number of factors given, chief among them being the optical aberrations, which were discussed in detail and numerically evaluated. It was concluded that at the present state of development of electron microscopy, resolving powers of the order of 10 Å should be obtainable.

After a discussion of constructional details of electron microscopes, a series of micrographs taken by the electron microscope was shown, and the results discussed. It was pointed out that the main applications of the electron microscope at the present time are in bacteriology, virus research, and in the wide field of colloidal research, including not only industrial colloids, but also all the building stones of living matter. (*Author's abstract.*)

The paper was discussed by Messrs. SMITH, HUMPHREYS, ROLLER, COE, MAHAN, READING, BEEK, FARNO, and others.

1168TH MEETING

The 1168th meeting was held in the Cosmos Club Auditorium, Saturday, May 11, 1940, President GIBSON presiding.

Program: J. H. SWARTZ, U. S. Geological Survey: *Resistivity studies of some geological problems.*—In El Paso, Texas, salt water was found to be encroaching upon a well from which a considerable portion of the city's water supply was at that time being drawn. Resistivity measurements were successful in determining the area underlain by salt water and in delineating the boundary between fresh and saline water areas. Salt water predicted for a city well at Clint, Texas, was encountered as predicted when the well was drilled despite the adverse prediction.

In the Hawaiian Islands large amounts of water are developed from thin basal lenses of fresh water floating on the salt water permeating the various islands. It was found possible by resistivity measurements to tell the thickness of such basal fresh water lenses and to determine quite accurately the elevation of the basal water table. Five test checks so far obtained at shafts, drill holes, and wells, have shown an average difference of 0.56 feet between predicted and observed water table elevations.

Studies of perched water horizons are now being made on the island of Maui. While still in an early stage due to the research character of the problem and the stratigraphic complexity involved, encouraging results have been obtained. (*Author's abstract.*)

F. W. LEE, U. S. Geological Survey: *Some problems in geophysics.*—As the science of geophysics has grown, especially in its application to prospecting, there has been a marked evolution in design and use of geophysical apparatus. During this evolution many traditional features of instruments have been improved whereas others have become obsolete. In the light of this progress it is very interesting to examine the many stages of development that scientific prospecting has undergone and is undergoing. Old dousing paraphernalia have been replaced by the magnetic dip needle, which in turn has been largely replaced by the more accurate and much more sensitive magnetic variometer. Magnetic interpretations have made a decided advance by the introduction of magnetic models and magnetic scales. Marked advances have also been made (by the sister methods) in electrical, seismic, and gravitational fields, and scientific prospecting is entering into a new era in which its application will, doubtless, be greatly broadened. In all of these branches of geophysical prospecting there are three distinct divisions which must be closely intercoordinated for securing the optimum results.

First, there is the instrumentation or the design and construction of precision field instruments. Experience in the oil industry shows how much advance can be made in instrument technique if the scientific results are coupled with the prospects of high economic returns. Second, there is the broad research associated with the many types of geologic bodies which commonly differ from territory to territory and also have many modifying controls and factors. Third, there is the theoretical principle involving the application of the magnetic, electric, gravitational, and seismic deformation fields to geologic and engineering problems. The analyses of physical field measurements in these fields often involve very complicated procedure. (*Author's abstract.*)

1169TH MEETING

The 1169th meeting was held in the Cosmos Club Auditorium, Saturday, May 25, 1940, Vice-President **BROMBACHER** presiding.

Program: **JOHN P. HAGEN**, Naval Research Laboratory: *Beam power tubes as ultra-high radio frequency generators.*—The increasing use of the lower radio frequencies by the existing commercial services has forced new services into the ultra-high frequency range. There are many features in the behavior of ultra-high frequency circuits and waves which invite their use even though a condition of saturation had not been reached in the lower frequencies.

The advent of tubes of the beam type, such as the Inductive Output Tube, the Klystron and the Velocity Modulated Tube, has made the use of the ultra-high frequencies practicable The essential features in the action of these tubes are: the production of a cylindrical beam of electrons; the acceleration of the beam by means of a high voltage anode which collects little current; the amplitude modulation of the beam by conventional grid action as in the Inductive Output Tube, or the velocity modulation of the beam as in the latter two types; the subsequent induction of the power from the beam to a plate tank circuit which collects little or no direct current. This tank circuit is usually some form of resonant transmission line; and the eventual collection of the beam, which has given up its radio frequency power, by means of a collecting anode at lower direct current potential. (*Author's abstract.*)

OSCAR NORGORDEN: *Propagation characteristics of ultra-high radio frequencies.*—One of the important links in a radio communication system is the propagation of the radio waves between the transmitting and receiving antennas. The electric field strength is proportional to the square root of the power and must exceed some definite value if to be useful for communication purposes.

At the ultra-high frequencies, frequencies above 100 megacycles, the transmitting and receiving antennas are elevated several wavelengths above the surface of the earth. For distances less than the optical range or line of sight the field strength E at the receiving antenna is

$$E = E_1 + E_2$$

where E_1 and E_2 are the electric fields at the receiving antenna due to the direct and reflected rays respectively. Thus an interference pattern should be observed for the variation of the field strength with distance. Measurements show that this interference pattern does exist and is in agreement with the theory. For distances greater than the optical range the field strength decreases exponentially with the distance. Thus the maximum useful communication distance for the ultra-high frequencies is nearly independent of the power and is approximately equal to the optical range. (*Author's abstract.*)

The first paper was discussed by Messrs. RAMBERG, SMITH, MAXWELL, and BLAIR; the second by Messrs. MAXWELL, BROMBACHER, BRICKWEDDE, SEEGER, BLAIR, and MOHLER.

RAYMOND J. SEEGER, *Recording Secretary.*

Obituary

CYRUS ADLER, president of Dropsie College for Hebrew and Cognate Learning, died at his home in Philadelphia on April 7, 1940. He was born in Van Buren, Ark., on September 13, 1863. He received the A.B. degree from the University of Pennsylvania in 1883, the A.M. in 1886. From Johns Hopkins University he received his Ph.D. in 1887. Hebrew Union College gave him his L.H.D. in 1925; University of Pennsylvania, his Litt.D. in 1930. He was in turn Fellow, Instructor, and Associate in Semitic languages at Johns Hopkins from 1884 to 1893. At the Smithsonian Institution in Washington he served successively as librarian, 1892–1905; as assistant secretary, 1905–1908; and as assistant curator and curator of historic archeology and historic religions, 1888 to 1908. He was elected president of Dropsie College in 1908; acting president of Jewish Theological Seminary of America in 1916, president in 1924. Throughout his life he was a tireless worker in the field of education and in recent years served as a member of the board of education in Philadelphia; as president of the board of trustees Philadelphia Free Library; and as a member of the board of Gratz College. He was a delegate to the conference on an International Catalogue of Scientific Literature in 1908 and since served as member of the international committee. Widely known as an educator, writer, and philosopher, Dr Adler was also one of the recognised leaders of the Jews in America.

The bibliography appearing in "Lectures, Selected Papers, Addresses" by Cyrus Adler, published by his friends and colleagues on the occasion of his 70th birthday, includes nearly 600 titles. In addition, there is a list of 17 publications "edited by Dr. Adler, or issued under his supervision." He was editor of the Jefferson Bible; of the American Jewish Year Book, 1899–1906; of the Jewish Quarterly, since 1910; and one of the editors of the Jewish Encyclopedia. His writings included Oriental, archeological, and philological subjects; he was an authority on comparative religion and American Jewish history. Among other organisations, Dr. Adler was a member of the Washington Academy of Sciences, a member and past officer of the American Philosophical Society; the American Jewish Historical Society; and the American Oriental Society. He was a member of the Cosmos Club in Washington and of the Oriental and University Clubs in Philadelphia.

JOURNAL
OF THE
WASHINGTON ACADEMY OF SCIENCES

Vol. 30 October 15, 1940 No. 10

CHEMISTRY.—*Cyanogenesis and enzyme activity in sorghum varieties.*[1]

James F. Couch and Reinhold R. Briese, U. S. Bureau of Animal Industry.

Our knowledge of the decomposition of cyanogenetic glucosides by their appropriate enzymes is based to a large extent upon the interaction of emulsin and amygdalin. This system has been subjected to much careful study (1, 3, 6, 9). Less is known about the interaction of other cyanogenetic systems such as prunasin-prunase and linamarin-phaseolunatase and very little about the highly important system dhurrin-dhurrinase which occurs in the sorghums.

Since the enzyme component regulates the rate at which HCN may be developed in a cyanogenetic system, the quantity or activity of that component in any given specimen of cyanogenetic plant is an important factor in the toxicity of the plant. Evidence accumulated in this laboratory during the past three years indicates that the active proportion of enzyme in cyanogenetic plants may vary considerably at different periods and under different conditions not only in the sorghums but also in species of wild cherry. The greater number of samples of sorghum appear to be deficient in dhurrinase, but occasional specimens occur in which there is ample enzyme to liberate the greater portion of the potential HCN in 3 hours. The wild-cherry species usually contain an abundance of enzyme, liberating all or nearly all the potential HCN in 2 to 3 hours, but rare samples occur in which the enzyme is deficient and cannot develop the entire quantity of potential HCN in the plant.

Variation in enzyme activity may explain the failure of some samples to produce poisoning in animals when chemical analysis indicates a toxic level of HCN. The lack of cyanogenetic enzyme in *Eremophila maculata* has been advanced by Finnemore and Cox (5) to explain the nontoxic nature of that plant when fed alone and its ability to produce HCN poisoning when some other material containing the enzyme is fed at the same time.

[1] Received May 9, 1940.

It is of interest to know whether the enzyme activity of plants like the sorghums bears any constant relationship to the quantity of potential HCN in the plant or whether these two factors may vary independently so that the rate at which the plant develops HCN may vary at different times. In the case of dried plants, such as hay, it is known that there is some loss of HCN during the curing process and the question of the effect upon the enzyme naturally arises. Some dried samples of sorghum and Sudan grass that have been kept for several years appear to have lost the greater part of their enzyme activity, although they retain considerable potential HCN. It is obvious that such hay would not be dangerous to livestock if the enzyme is insufficient to develop a toxic quantity of HCN when the hay is eaten. It is evident, therefore, that in some cases the quantity of enzyme present in the plant may be the factor that determines whether poisoning occurs. In view of these considerations it becomes highly desirable to work out some method whereby the activity or quantity of the enzyme can be evaluated. Until this has been accomplished it will be difficult to study the factors that influence the formation and storage of the enzyme in the living plant.

In attacking the problem of working out some method by which a numerical index could be assigned to the enzyme activity of a cyanogenetic plant, it was thought that some indication might be obtained by observing the percentage of the total potential HCN that might be obtained after various periods of maceration. A number of data were obtained in this way which, while they clearly indicated variation in the enzyme activity at different times, were not adapted to mathematical treatment and did not lead to any quantitative knowledge of the enzyme. Samples of these same plants to which an enzyme had been added and others to which a solution of the glucoside was added were run at the same time as the untreated samples. The purpose was to supply enzyme if that factor was deficient or in case the enzyme should be in excess to supply enough glucoside to get an index of the excess. In both cases the results, while informative, were not of such a nature as to yield a numerical index of the enzyme activity. The failure in these attempts may be due to the fact that in the decomposition of dhurrin or of prunasin, two enzymatic processes are occurring, the hydrolysis of the ether linkage with splitting off of the sugar molecule and the hydrolysis of the nitrile to produce HCN. Whether both of these reactions are catalyzed by the same enzyme or whether two enzymes are concerned is not known, nor have we any knowledge that one reaction takes precedence over the other or that the two proceed concurrently. If one enzyme only is concerned and if one reaction proceeds more rapidly than the other, it is possible that the enzyme might be quite inhibited in partially hydrolyzing a large quantity of glucoside and thus produce very little of the completely hydrolyzed products. We have some evidence that in the case of dhurrin glucose is split off the molecule more rapidly than HCN. Should some of these possibilities be true, the problem of accurately evaluating the quantity of enzyme may be quite complex.

A study of the rate at which the enzyme hydrolyzes a definite quantity of glucoside should yield figures from which the approximate quantity of enzyme present could be inferred. This is especially true in the earlier stages of the process where, as shown by Auld (1) the reaction follows the law for monomolecular reactions. O'Sullivan and Tomson (8) used the time required for the performance of a certain amount of work as an index of the activity of invertase and the idea was applied to emulsin by Helferich (6) and by Willstätter and Csanyi (9). Helferich determined this "Zeitwertquotient" as the time required to hydrolyze 50 percent of substrate. The application of this method to plants is limited by the fact that it is not possible arbitrarily to alter the relative proportions of glucoside and enzyme present but one must accept the mixture as it naturally occurs. The addition of enzyme or glucoside to macerating plant mixtures is only partially satisfactory since much of the natural enzymolysis takes place within the plant tissues and there is considerable doubt that much of the plant enzyme goes into solution in the external fluid where the added glucoside is. On the other hand, there is little doubt that much of the added enzyme does not penetrate the plant tissues and come in contact with the plant glucoside.

EXPERIMENTAL

Twelve varieties of sorghum grown at the Bureau of Plant Industry Experimental Farm, Arlington, Va., were made available for this season through the courtesy of Dr. J. H. Martin, of the Bureau of Plant Industry, who helped in the selection of the varieties and arranged for the planting and cultivation of the crop. The 12 varieties studied were Dwarf Yellow milo, Ajax, Spur feterita, Sharon kafir, Grohoma, Sagrain, hegari, Leoti sorgo, Sumac sorgo, Kansas Orange sorgo, Rex sorgo, and Atlas sorgo.

It was planned to determine in each plant collection the HCN liberated without preliminary maceration and after water maceration for 1, 2, 3, 4, 24, and 48 hours, and after mercuric chloride preservation for 4 weeks, 8 weeks, and 6 months. When there was a shortage of material, certain of the least essential samples in this series were omitted. Samples were collected

TABLE 1.—HYDROCYANIC ACID RECOVERED FROM SORGHUM VARIETIES AFTER MACERATION FOR DIFFERENT PERIODS IN WATER AT 37° C

Coll. No.	Date 1939	Variety	Moisture	Height	Hydrocyanic acid (mg per 100g of dry plant) recovered after maceration in water, hours: 0	1	2	3	4	24	48	in HgCl$_2$ (a), weeks: 4 and 8 (a)	Time at 50% hydrolysis	Rate index	Remarks
			%	in.	mg	mg	mg	mg	mg	mg	mg	mg/%	hrs.		
15	July 10	Hegari	88.11	6-10	18	27	56	153	172	242		309	3.4	45.6	Suckers
[illegible]	Aug. 8	do	89.89	10-12	30	50		205	274	354	304	402	3.	67.	2nd growth
45	Aug. 22	do	87.00	10-12	35	33		165	210	316	302	305	3.2	90.	do
14	July 20	do	86.26	12-14	14	18	33	88	191	250		309	3.4	45.6	
23	July 17	do	79.76	24	20	31	39	44	50	140	188	208	13.0	6.6	
27	July 24	do	81.96	24-26	24	34	43	64	75	159	151	[illegible]	24.	5.9	
31	July 31	do	78.22	48	10	21	77	55	75	207	209	[illegible]	10.3	12.	
36	Aug. 7	do	78.57	60	13	25	29		40	164	164	[illegible]	9.4	12.	
42	Aug. 14	do	76.48	72	11	16		29	30	105	172	206	24.	4.3	
44	Aug. 21	do	75.58	60-72	15	19		31	34	107	165	202	22.4	4.5	
46	Aug. 28	do	76.11	72	14	25		29	31	116	137	175	13.2	6.7	
49	Sept. 5	do	74.66	72	10	21		25	34	82	88	121	15.3	4.	
50	Sept. 18	do	71.36	72	10	17		29	34	56	70	93	20.	4.7	
52	Sept. 25	do	71.22	72	10	22		38	51	54	47	80 (b)	5.2	12.7	
54	Oct. 9	do	68.20	72	7	19			34	44		75	5.4	6.9	
55	Oct. 17	do	84.86	8-12	40	42		62	96	198	208	297	8.4	37.7	Frosted; 2nd growth.
57	Oct. 26	do	72.00	72	13	30		40	45	55	50	82 (b)	3.4	12.1	do
21	July 14	Spur feterita	88.47	6-8	28	27	69	249	209	278		285	3.	47.	Suckers
18	July 22	Kansas Orange sorgo	88.87	8	20	20	26	80	158	160	177	213	3.1	34.5	do
17	July 22	Leoti sorgo	86.95	8	18	20	31	75	107	135	112	205	3.0	27.1	do
22	July 24	Sagrain	88.74	8-12	15	17	49	115	160	187		201	2.7	37.	
5	July 6	Spur feterita	85.42	12	85	[illegible]	69	173		290		292	2.6	54.1	
4	July 5	Dwarf Yellow milo	85.24	12	85	[illegible]	61	138	146	213		266	2.0	47.5	
10	July 13	Ajax	85.81	12	15	[illegible]	29	85	120	143	148	200	3.1	32.3	
12	July 7	Atlas sorgo	87.68	12	17	[illegible]	51	115		153		239 (b)	3.6	33.3	
6	July 6	Grohoma	89.21	12	18		45	106		247		235	3.8	31.	
[illegible]	July 7	Dux sorgo	85.99	12	24		35	82		155		241 (b)	5.0	28.9	
28	July 28	Sumac sorgo	84.95	10-14	9	12	41	84	108	158	139	159	3.3	29.	Suckers
16	July 11	do	86.84	12-14	11	12	34	108	152	220		257	3.3	40.6	
20	July 15	Sharon kafir	85.80	12-14	8	8	17	55	56	55		101	3.7	13.8	
43	Aug. 15	Ajax	88.16	6-8	67	49		336	392	444	301	407	2.8	200.5	2nd growth
58	Sept. 26	Spur feterita	87.48	6-10	85	77		154	179	227	198	448	2.	60.	do
56	Oct. 11	Ajax	83.44	8-12	21	25		92	132	163	152	[illegible]	3.3	34.2	do
40	Aug. 9	Sharon kafir	88.42	10-12	22	26		84	107	159	136	183	3.2	28.6	do
47	Aug. 29	Dwarf Yellow milo	92.55	12-14	32	34		70	153	227	244	338	4.8	53.1	do
26	July 20	Spur feterita	85.15	20-22	42	59	82	99	188	276	256	275	4.4	31.	Suckers
25	July 19	Sharon kafir	82.34	24-26	16		33	39	48	61	59	91 (b)	5.4	8.4	
30	July 25	Sumac sorgo	81.79	36	15	29	44	65	73	131	141	144	9.3	9.9	
37	Aug. 4	Dwarf Yellow milo	79.21	36	11	21		40	47	115		144	8.3	8.8	
[illegible]	July 26	Sharon kafir	79.73	38-40	10	18	29	35	78	76	64	91	7.6	6.	
[illegible]	July 28	Atlas sorgo	82.70	48	24	18	33	42	55	78		88	3.2	13.4	
34	Aug. 3	Spur feterita	78.71	54	27	43		65	82	210	201	259	9.4	15.8	
[illegible]	Aug. 2	Sumac sorgo	80.22	72	10	35		42	47	139	116	192	12.	6.3	
41	Aug. 10	Sumac sorgo	76.36	72	12	19		35	45	86	135	145	14.4	5.6	

(a) Highest value in 4 and 8 weeks' maceration in mercuric chloride ($HgCl_2$) is given. (b) The 8-week sample was over 5% lower than the 4-week.

daily throughout the season at 8:30 A.M. and taken at once to the laboratory, where they were immediately sliced fine or ground for analysis. The whole plants were sliced so long as no pith was present. As soon as pith began to appear, that part of the stalk containing the pith was discarded. When the plants became fibrous and tough the leaves were stripped off and ground in a food chopper, the stalks and heads being discarded. Fifty-gram samples were used whenever sufficient material was on hand and the plant was weighed out (before grinding or slicing) in slight excess for the number of analyses planned. The sliced or ground plant was mixed thoroughly and weighed at once into flasks and jars assembled in advance. The samples for water maceration were placed in 5-liter round-bottom flasks and stoppered with a rubber stopper. Those for mercuric chloride preservation were placed in pint fruit jars. As soon as the last sample had been weighed, the contents of the jars were flooded with water and ½ gram (1 percent) of mercuric chloride in solution added to each. The jars were then filled to the shoulder with water, covered, shaken well and stored at 25° C. until the time of analysis. In the meantime a flask of water had been brought to boiling. For the time series it was necessary to stop all enzyme action promptly at the beginning of the analysis. This was accomplished quite effectively with boiling water and mercuric chloride To the sample marked zero hours, 1,500 cc of boiling water containing 1 gram (2 percent) of mercuric chloride was added The flask was connected to a condenser and the burner lighted at once As soon as vapor began to condense in the delivery tube above the stopper, 2 grams of stannous chloride in water was added, the connections quickly reinserted, and without removing the flame the mixture was well shaken while holding the stoppers firmly in place. The HCN was then distilled off and caught in a 500-cc Erlenmeyer flask containing 10 cc of 5 percent potassium hydroxide. Two distillates of 400 cc each were taken for each sample For the remaining samples a quantity of warm tap water sufficient for 500 cc per sample was run into a large container and adjusted to 37° C To each flask was added 500 cc as rapidly as it could be measured in a graduate and the rubber stoppers reinserted. The flasks were placed at once in the incubator at 37° C. The whole operation of adding the water required from 3 to 6 minutes, depending on the number of samples in the series. When the period of maceration had elapsed for each sample, it was diluted to 1,500 cc with 1,000 cc of boiling water containing 1 gram (2 percent) of mercuric chloride. The flask was then connected, heated, stannous chloride added, and the contents distilled just as in the case of the zero hour sample. The HCN content of the distillates was determined as previously described (2).

The amount of HCN liberated each hour for the first four hours was determined in these experiments because an animal that is to become poisoned from sorghum will ordinarily show the effect within four hours. The animal will very likely not become poisoned if no effect is produced within four hours after the plants are eaten.

DISCUSSION OF RESULTS

The data obtained in the experiments are tabulated in Tables 1 and 2. The data in Table 1 are expressed in milligrams of HCN per 100 grams of plant calculated to the dry basis. Columns 6 to 12 give the figures for the amount of HCN liberated by water maceration during intervals of 0, 1, 2, 3, 4, 24, and 48 hours. The total amount of potential HCN in the plant as determined by 4 and 8 weeks of maceration in mercuric chloride is shown in column 13, the highest value thus obtained being given and the values similarly expressed in mg of HCN per 100 grams of dry plant. Column 14 gives the time in hours at which 50 percent of the potential HCN had been liberated. These values were obtained from graphs of the figures for the number of milligrams of HCN liberated against the time intervals 0, 1, 2, 3, 4, and 24 hours corresponding to these figures. Column 15 gives the rate index for 50 percent hydrolysis. This figure indicates the number of milligrams of HCN obtained per hour up to the time at which 50 percent of the potential HCN had been liberated and was calculated from the data in columns 13 and 14 The data in Table 1 are arranged according to height of plants The number of milligrams of HCN liberated at the stated time for hegari are given in the first four sections of the table. Similar figures are given in sections 5 and 6 for 11 varieties of first-growth plants and 4 varieties (5 samples) of second-growth plants all less than 15 inches in height. The last section gives the figures for plants 2 feet or more in height for all varieties excluding hegari. Spur feterita, 20–22 inches high, was placed in this section although slightly less than 2 feet high. This sample is the exception mentioned in the next paragraph.

TABLE 2.—SORGHUM VARIETIES LIBERATING THE HIGHEST AND LOWEST PERCENT OF THE POTENTIAL HYDROCYANIC ACID FOR DIFFERENT PERIODS OF MACERATION OF THE SAMPLES IN WATER AND IN MERCURIC CHLORIDE

Time of maceration in water	Highest			Lowest		
	Variety	Coll no	HCN liberated	Variety	Coll no	HCN liberated
hrs		1939	%		1939	%
0	Sharon kafir	25	17 6	Hegari	31	4 0
1	Hegari (frosted)	87	36 8	Sumac	16	4 5
2	Atlas sorgo	30	37 5	Hegari	14	11 2
3	Ajax	43	69 0	Hegari	42	14 1
4	Ajax	43	80 5	Hegari	31	14 2
24	Spur feterita	21	97 5	Hegari	55	41 2
48	Spur feterita	26	93 8	Leoti sorgo	17	54 6
In $HgCl_2$	Ajax	43	487 mg.	Hegari	54	73 mg

The data in Table 1 reveal the outstanding fact that young sorghum liberates HCN at a much higher rate than older plants. The rate index expresses this fact numerically. All the high values for the rate index are seen to be associated with the sorghums less than 15 inches in height, sections 1, 5, and 6, with one exception, namely, Spur feterita, 20–22 inches high in section 7, which has a rate index of 31 although it is nearly 2 feet in height. Another exception is Sharon kafir, section 5, young first growth which has a rate index of 13.8 while the next lowest value in this section is 20.9. No explanation for these exceptions can as yet be given.

A comparison of first and second growth sorghum brings out the fact that some samples of second growth have an exceptionally high rate index. For example second growth Ajax with a potential HCN value of 487 milligrams has a rate index of 100.5 and Spur feterita has corresponding values of 240 and 60. The highest value for young first growth was that of Spur feterita with a potential HCN value of 292 milligrams and a rate index of 56.1. This comparison between first and second growth is well brought out by the respective averages calculated from Table 1, as given in Fig. 1, in which the percentages of the potential HCN liberated are plotted for the various time intervals. The curves show that 50 percent hydrolysis is reached earlier in the case of second growth plants so far as can be determined by a small number of samples.

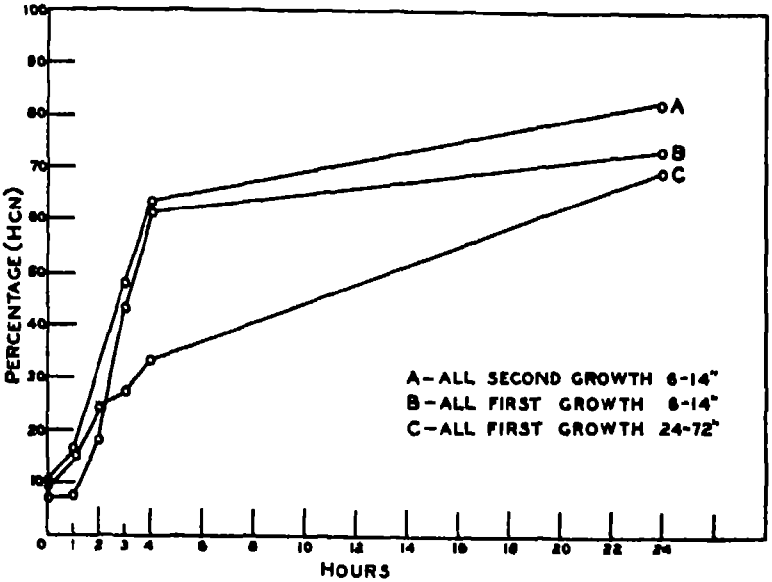

Fig 1.—Average percent of the potential hydrocyanic acid liberated from sorghums after maceration in water for different periods of time

The activity of the enzyme as indicated by the rate index is a factor determining the rate of evolution of HCN and hence the toxicity of sorghum. The high rate indices associated with young plants, including second growth, first growth and suckers, indicate that sorghum in its early stages of growth is a dangerous food for livestock. From the present state of our knowledge it is as yet impossible to say whether plants with low rate indices are toxic to animals when eaten in large quantities and if so what determines the toxic level for such plants.

The rate index is independent of the quantity of potential HCN in the plant. A comparison of the amount of potential HCN in sorghum with the corresponding rate indices showed that there was no correlation between the two. Samples with a potential HCN content of 200 and 206 milligrams showed rate indices of 32.3 and 4.3, respectively. Similar discrepancies were numerous throughout the list.

It is of interest to note which varieties of sorghum liberated the lowest percent of the potential HCN and which the highest for the different periods of maceration in water and in mercuric chloride. Data for such a comparison are given in Table 2. Hegari is shown to be the lowest in 6 out of 8 instances and Sumac sorgo and Leoti sorgo each in one instance. Among the highest are Atlas sorgo, Ajax, and Spur feterita.

In Fig. 1 the curve or the averages of all first growth plants 2–6 feet in height shows a slowing up of the rate of evolution of HCN between the 2- and 3-hour points followed by an increase. All samples from plants of this size were ground in a food chopper for analysis. Hence a certain amount of glucoside and enzyme from the crushed sample were in intimate contact and therefore the hydrolysis proceeded more rapidly from the beginning than in the case of sliced first growth plants. The grinding, however, was not sufficiently fine to expose all the glucoside and enzyme and a certain time would be required for the penetration of the solvent and subsequent diffusion of the reactants and reaction products. The result is a slowing up of the reaction rate as indicated by the curve after the 2-hour point in the averages. Young plants, which contain more water and are less fibrous, permit a rapid diffusion of glucoside and enzyme and do not show this phenomenon. No analyses were made this season for periods between 4 and 24 hours. It is conceivable that this slowing of the reaction could occur later than at the 4-hour period in a sample with a slow reaction rate and if at the same time the curve in this area was rather flat a dip could occur due to the rate of destruction of HCN for a time exceeding the rate of its formation. Such a dip has been discussed in a previous publication (2).

It is of interest to calculate how much difference in toxicity the variation in rate of evolution of HCN would be expected to make. Taking the m.l.d. of HCN for cattle as 2 mg per kg and for sheep as 2.3 mg per kg, then on the basis of the average of actual HCN evolved from hegari in 4 hours, the 8–14 inch plants would furnish one m.l.d for a 300-kg cow in 281 g of plant; the 24–26 inch plants in 1,215 g and the 6-foot plants in 1,378 g. For a 50-kg sheep the figures are: 53.8 g, 233 g, and 264 g. respectively. The potential HCN contents (average) of the plants are as 100: 71.7:32 percent.

SUMMARY

The activity of the enzyme determines the rate at which a cyanogenetic plant evolves HCN and so is a determining factor in the toxicity of the plant. Unless the enzyme is sufficiently active to evolve a toxic quantity of HCN quickly, poisoning is not likely to occur.

Young second-growth and first-growth plants including suckers have a much higher rate index than leaves of well-developed sorghum varieties and consequently are to that extent more likely to cause poisoning. Whether plants with a low rate index are toxic when larger quantities are eaten and if so what determines the toxic level for such plants are questions requiring further investigation.

The enzyme activity of a cyanogenetic plant may be numerically defined as the number of milligrams of HCN evolved per hour until 50 percent of the potential amount has been set free under certain conditions of temperature and dilution. The figure is referred to as the "rate index."

The rate index was determined for a number of varieties of sorghum collected at Arlington Farm during the summer of 1939. The rate index is high for young plants of all varieties less than 15 inches high and low for plants of all varieties above 2 feet high. The rate index is not correlated with the quantity of potential HCN and varies independently of it. Consequently the activity or quantity of the enzyme in the plants is not a function of the quantity of dhurrin.

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PALEOBOTANY.—*A bracket fungus from the late Tertiary of southwestern Idaho.*[1] ROLAND W. BROWN, U. S. Geological Survey.

The specimen to be described here was collected in 1939 by James L. Morris, registered engineer of Boise, Idaho, at a locality about 1½ miles east of a point 5 miles south on the highway from Bruneau, Idaho, to Owyhee, Nev. Associated with this specimen on the surface at the same locality is much fossil wood, which includes species of fir (*Abies*), alder (*Alnus*), poplar (*Populus*), oak (*Quercus*), and hickory (*Hicoria*). From a sketch and photograph submitted by Mr. Morris, it would appear that the fossils occur in a stratum lying just above a white bed of volcanic glass sand. These strata may be part of the Idaho formation, which in the course of its history has been made to include a rather heterogeneous series of lake and basin deposits lying above the Columbia River basalt. The presence of undoubted hickory among the fossil woods suggests a much moister climate than that now prevailing in the area, and it also suggests that the age of that part of the formation is probably not later than early Pliocene.

Analysis of the specimen shows that it is composed principally of calcium carbonate with minute amounts of other substances, some of which may have come from clay or other extraneous material lodged in the pores subsequent to the calcification of the specimen. The fact that this fungus and the woods are calcified, with preservation of the original cellular structure as perfect as the best examples of silicified specimens of the same kind, raises some questions that the writer can not answer at this time, such for example as: What was the probable immediate source of the calcium carbonate? Why did calcification take place instead of silicification? A thorough examination of the geological setting would doubtless throw light on these matters, but the writer has not had an opportunity to visit the locality. According to the sketch there are now hot springs 6 miles east of this locality, but whether these or similar springs that may once have existed closer by had anything to do with this fossilization is only conjectural. It would seem that definite answers to these questions might perhaps precipitate the long-sought solution to the problem as to how calcification and silicification take place.

POLYPORACEAE

Fomes idahoensis Brown, n. sp. Figs. 1–4

This specimen is the sporophore or spore-bearing portion of a bracket fungus. It is 13.5 cm long and 4.5 cm thick. The upper surface (Fig. 1) is or

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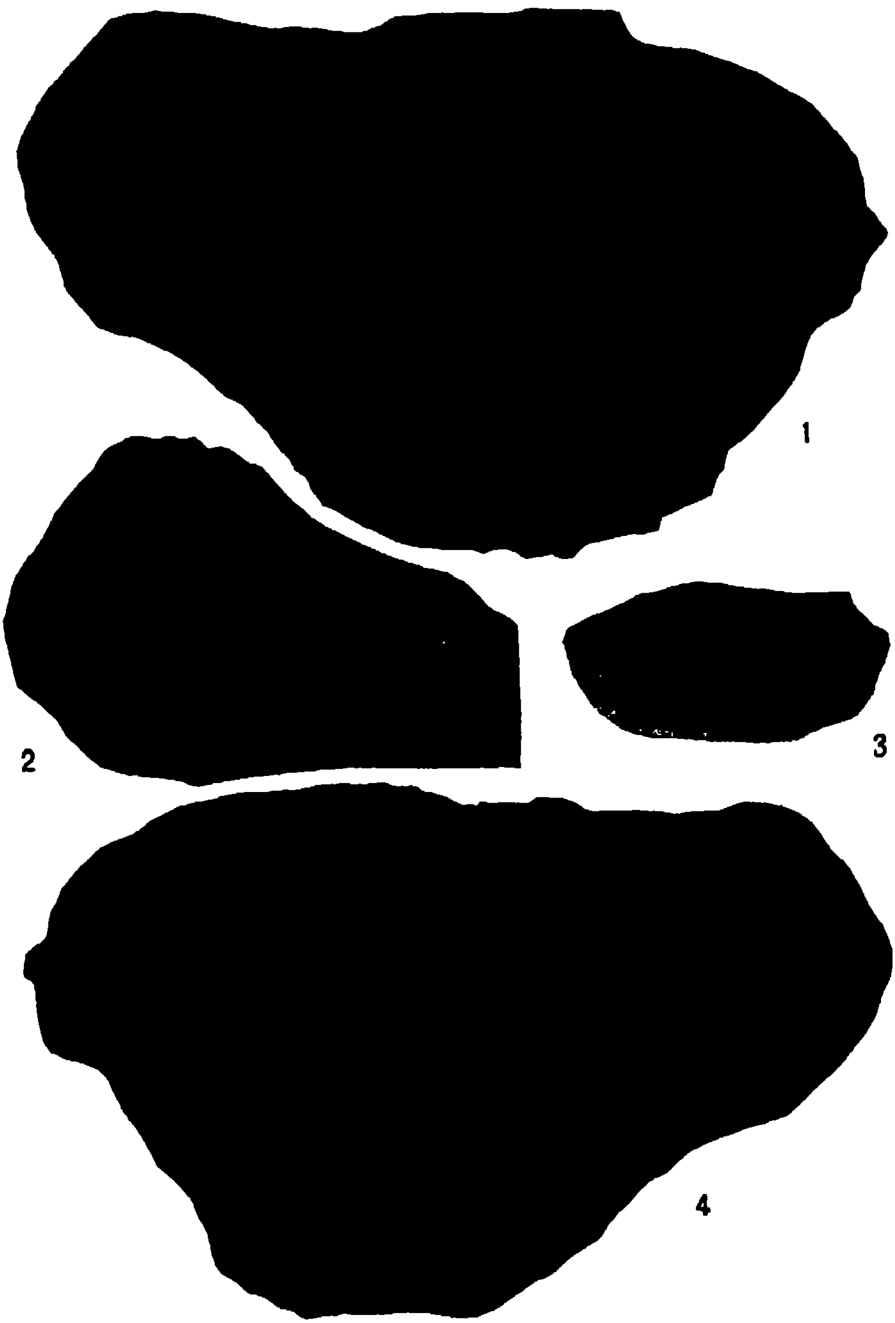
[1] Published by permission of the Director, Geological Survey, U. S. Department of the Interior. Received May 29, 1940.



Figs. 1–4.—*Fomes idahoensis* Brown, n. sp : 1, View of top; 2, pores, ×4; 3, side view showing context above and pore area below; 4, view of bottom. Figs. 1, 4, ×[illegible].

was fairly smooth and displays a series of convex-rounded "rings" of growth. The under surface (Fig 4) is flat and porous, the pores numbering about 750 per sq. cm. These are shown in Fig. 2, magnified four times. Fig. 3 is a cross section through the right hand end of Fig. 4 and illustrates the vesicular corky context separated from the pore area by an irregular dark zone. Microscopic examination reveals no spores or other significant cellular structures.

The specimen resembles the living bracket fungus, *Fomes pinicola* (Swartz) Cooke, so closely that no doubt exists as to its affinities. The only difference appears to be in the size of the pores, which are slightly larger in the fossil, thus aggregating only about 750 per sq. cm as compared with about 1,000 in *F. pinicola*. The species of the genus *Fomes* attack many kinds of trees. *Fomes pinicola* is found on conifers generally and is not confined to *Pinus* specifically as the name might suggest The fossil may have lived on one of the numerous species of conifers recorded from the late Tertiary of the western United States.

Mason[2] records *Fomes applanatus* (Persoon) Gillot from the Pleistocene of the Tomales Bay region, Calif. This appears to be the only other authentic American fossil polypore fungus Those described by Wieland and Brown in 1934 and 1936, respectively, have since been shown by Brown[3] to have been misidentified Seward[4] in 1898 accepted as authentic several records of Polyporaceae from Europe, the earliest being an Oligocene species of *Polyporus* described by Conwentz from the Baltic amber deposits. Meschinelli,[5] however, records a number of additional species.

The writer expresses appreciation for help in this study to John A. Stevenson, U. S. Bureau of Plant Industry, and Kiguma J. Murata, U. S. Geological Survey.

[2] MASON, H. L *Pleistocene flora of the Tomales formation* Carnegie Inst. Washington Publ 415(4): 143, pl 5, figs. 1, 4. 1934

[3] BROWN, ROLAND W. *Two fossils misidentified as shelf-fungi.* Journ Washington Acad. Sci. 28: 130–131. 1938.

[4] SEWARD, A. C. *Fossil plants.* 1: 207–222 1898.

[5] MESCHINELLI, A *Fungorum fossilium omnium hucusque cognitorum iconographia.* 1898.

BOTANY.—Oxytenanthera felix, *a new species of bamboo from Yunnan, China.*[1]

Y. L. Keng, National Central University, Chungking, China. (Communicated by Agnes Chase.)

The genus *Oxytenanthera* Munro comprises about 20 species, from tropical Asia, New Guinea, and Africa. The species here described is the first known from China.

Oxytenanthera felix Keng, sp. nov.

Culmi teretes, 9 m alti, ramis foliiferis (in specimine) usque 90 cm longis, 5 mm crassis, basi squamis glabris stramineis cinctis; vaginae sese arcte involventes, infima 12 cm longa, glabrae vel superiores pilis adpressis 0.5–1 mm longis strigosae; ligula firma, 3–4 mm longa, saepe bipartita; laminae saepissime 30–45 cm longae, 4.5–6 cm latae, acutissimae, glabrae, basi in petiolum 4–7 mm longum attenuatae, margine scaberulae vel veteres fere laeves; rami floriferi simplices, aphylli, subherbacei, usque 2.5 m longi, internodiis inferioribus circ. 15 cm longis, 9 mm crassis; spiculae dense fasciculatae vel plurimae in capita magna usque 5 cm crassa dispositae, pleraeque 4-florae, 16–20 mm longae, pallide virides vel ad maturitatem stramineae; glumae 1–3, late ovatae, 3–9 mm longae; lemmata ovato-lanceolata, 11–17 mm longa, multinervia, superiora convoluta, pungenti-mucronata; palea multo angustior, 11–15 mm longa, suprema convoluta, inferior bicarinata, carinis marginibusque superne longe ciliata; lodiculae nullae; stamina 6, filis inferne connatis, hyalinis, usque 15 mm longis, antheris 4–7 mm longis, apice minute hispidulo (interdum fere glabro) apiculatis; ovarius linearis, stipitatus, in stylum hispidulum circ. 1 cm longum attenuatus, stigmato uno, plumoso, circ. 9 mm longo.

Culms terete, 9 meters tall, the leaf-bearing branches (in specimen) arising singly from the nodes of the main culm or primary branches, about 6 mm thick and medullated with whitish-flocculose pith, covered at base with glabrous stramineous scales, about 90 cm long, the lower 4 internodes 6–16 cm long, glabrous; sheaths 10 on the upper part of the leafy branch, tightly overlapping, the lowermost 12 cm long, keeled or the midnerve prominent above, glabrous or the upper strigose with appressed hairs 0.5–1 mm long; ligule firm, prominent, 3–4 mm long, frequently 2-partite or sometimes concave at apex; blades mostly 30–45 cm long, 4.5–6 cm wide, with a strong midnerve and 10–13 secondary nerves on either side, cross-veined, sometimes obscurely so, acuminate-pointed, cuneate at base with a petiole 4–7 mm long, glabrous or the pale lower surface very sparsely strigose with appressed deciduous hairs, the margins scaberulous or in age nearly smooth; floriferous branches simple, aphyllous, up to 2.5 meters long, the lower greenish subherbaceous internodes about 15 cm long, 9 mm thick; spikelets densely clustered or numerous in large heads up to 5 cm thick, usually 4-flowered, 16–20 mm long, pale green or stramineous at maturity; rachilla joints very short or the nodes nearly approximate; glumes 1–3, broadly ovate, acute or obtusish, successively longer, 3–9 mm long (when 3, the first sometimes keeled, the keel ciliate, the second sometimes paleate), multinerved, cross-veined, glabrous or the margins ciliolate; lemmas ovate-lanceolate, 11–17 mm long (the lowermost sometimes only 7 mm long, broadly ovate, staminate), multinerved, the upper ones usually convolute, pungent-mucronate,

[1] Received April 30, 1940.

glabrous or the margins ciliolate above; palea very narrow (about 1.5 mm wide between the keels), 11–15 mm long, the uppermost convolute, the lower ones 2-keeled the keels and the inflexed margins long-ciliate above; lodicules none; stamens 6, the filaments connate into a tube around the pistil, hyaline, up to 15 mm long, the anthers 4–7 mm long, apiculate with minutely hispidulous tip (or sometimes nearly glabrous); ovary linear or somewhat enlarged at base when ripe, stipitate, hispidulous, attenuate into a hispidulous style about 1 cm long, then continuous with a plumose stigma about 9 mm long.

Type in the U. S. National Herbarium, nos. 1214319 (flowering specimen) and 1214320 (leaf-bearing specimen), collected on plain of the Nam Ha, between Muang Hai and Keng Hung, Yunnan Province, altitude 1,260–1,350 meters, February 15–17, 1922, by J. F. Rock (no. 2462).

BOTANY.—*Taxonomic relationships in the genus* Gossypium.[1]

S. C. Harland, Sociedad Nacional Agraria, Lima, Peru. (Communicated by T. H. Kearney.)

There have been three recent papers dealing with the classification of the genus *Gossypium:* Hutchinson and Ghose (1937), Hutchinson (1938), and Hutchinson (1939). The third of these is a condensed and modified version of the first two. The discussion of Hutchinson and Ghose (1937) on the taxonomy and relationships of the Asiatic cottons calls for no comment. It seems to the writer an accurate and painstaking attempt to straighten out a confused and complicated situation. The treatment of the other groups is less satisfactory. First, a slight error is made in the statement that *G. davidsonii* and *G. klotzschianum* do not cross with cultivated New World cottons. Both in fact do cross with Sea Island cotton (*G. barbadense* L.) but produce seedlings that, although germinating vigorously, die when young through a progressive necrosis of the cotyledons.[2] Exception must also be taken to the statement that the two Australian species *G. sturtii* and *G. robinsonii* are probably best classified with the New World diploid cottons. About *G. robinsonii* we know nothing except from herbarium specimens, so that it may be removed from the discussion. Information on the relationship of *G. sturtii* to other diploid species is derivable only from cytological sources (Webber, 1935, 1936, and Skovsted, 1937).

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[1] Received June 14, 1940. The writer is indebted to Dr. T. H. Kearney and to Dr. H. J. Webber, who have read this manuscript and furnished valuable suggestions.

[2] Dr J. M. Webber informs the writer (April 24, 1940) that he has obtained one plant from the cross *barbadense*×*davidsonii* which grew normally and flowered profusely, exhibiting the most typical Drosera scheme meiotic chromosome behavior ($13_{II}+13_{I}$) of any *Gossypium* hybrid yet examined.

Webber (1936) reported the following results in crosses between *sturtii* and New World diploids:

Cross	Type of Conjugation
sturtii × *amourianum*	$0_{II}+26_{I}$ (most) to 6_{II} 14_{I}
sturtii × *harknessii*	$0_{II}+26_{I}$ (most) to 4_{II} 18_{I}
davidsonii × *sturtii*	$0_{II}+26_{I}$ (most) to 5_{II} 16_{I}
thurberi × *sturtii*	26_{I} (all)

In a later communication Webber (1939) gave further data as follows:

Cross	Univalents	Bivalents
G. sturtii × *G armourianum*	24 08	0 96
G. sturtii × *G. harknessii*	24 56	0 72
G. davidsonii × *G sturtii*	23 94	1 03
G thurberi × *G. sturtii*	24 52	0 74

Skovsted (1937) presented cytological data on crosses between *sturtii* and (a) *davidsonii*, (b) *armourianum*, and (c) Asiatics. He gave the following results:

Cross	Univalents	Bivalents	Trivalents	Quadrivalents
davidsonii × *sturtii*	14 95	5 32	0 10	0 02
sturtii × *armourianum*	8 45	8 20	0 25	0 10
Asiatic × *sturtii*	2 0–3 7	9 5–10 2	0 5–0 8	0 3–0 45

Here it is evident that *sturtii* is cytologically closer to the Asiatic cultivated cottons than to the New World diploids. Skovsted states that pollen mother cells with 13 bivalent chromosomes are found in the hybrids between Asiatic cottons and *G. sturtii* and between Asiatic cottons and *G. anomalum*, and again, "*G. anomalum* and *G. sturtii* separated in different directions and to different continents. They yet retain sufficient cytological similarity with Asiatic cottons to permit of fairly normal conjugation in their hybrids." If therefore *sturtii* is to be classed with any other group, it should, agreeing with Skovsted, go with the Asiatic and not with the American diploids. Webber, however (1939), obtained in the cross *herbaceum* × *sturtii* 21.56 univalents and 2.22 bivalents. Since cytological criteria disagree and genetical criteria are entirely lacking, owing to complete sterility of all recorded crosses, it seems best pending further evidence to put *sturtii* in a group by itself, as has been done by the writer (1939).

Some comments may now be offered on certain changes that Hutchinson and Ghose (1937) and Hutchinson (1937–38) propose to make in the taxonomic status of some species in the tetraploid New World cottons and that differ from the schemes put forward by the writer (1932, 1939).

The specific rank assigned *darwinii*, *tomentosum*, *barbadense*, and *taitense* is not in dispute, but regarding the remaining species, two species and one subspecies were recognized in the writer's first scheme (1932): (1) *G. hirsutum* L. (the American Upland of commerce); (2) *G. purpurascens* Poir. (the Bourbon group), including *G. punctatum* Sch. and Thon. (the *punctatum* group). Later, the writer (1939) tentatively and hesitantly gave specific rank to *punctatum*. Hutchinson and Ghose (1937) followed this scheme but changed the name *G. purpurascens* to *G. religiosum*. In a later communication Hutchinson made a further modification and proposed that *purpurascens* and *punctatum* should now be considered as varieties of *hirsutum* under the names var. *purpurascens* and var. *religiosum*.

Now since the writer disagrees with the first taxonomic change in so far as *purpurascens* is termed *religiosum*, and with the second change in so far as *purpurascens* and *punctatum* are made varieties of *hirsutum*, it seems to be necessary to discuss the interrelationships of *hirsutum*, *purpurascens*, and *punctatum* rather fully. Let us first define what we mean by the terms. By *G. hirsutum* L. we mean the huge and variable assemblage of forms comprised under the name American Upland cottons. The type of the species is in the Sloane Herbarium, B. M., vol. 294, p. 45 (Miller's specimen named by himself). It is important to note that the type herbarium specimen consists of a small branch with seven or eight leaves and two flowers (or buds). To use it as an accurate means of discriminating between the modern *hirsutum* and related species can be done only by a process of rationalization and might well be merely taxonomic pedantry.

A whole series of minor details of form which characterize *hirsutum* are not visible in the specimen. It can not be said, for example, whether the specimen is derived from a monopodial or sympodial plant, or whether the flower is really characteristically *hirsutum*. It is true that the very special leaf shape of *hirsutum* is present, and this delimits it from *barbadense*, a species in which this leaf shape is unknown. The process we have to go through, then, is this: We identify (rightly or wrongly) the type specimen of *G. hirsutum* L. with the modern *hirsutum*. We then compile a taxonomic description of *hirsutum* from modern material and in the process discover what are the characters of taxonomic significance, which probably are not visible in the original specimen and which really do characterize *hirsutum* and mark it off as a good species. We go through the same process with other species thought to resemble an original type specimen, and then, by using a combination of methods in which anatomy, morphology, ecology, geographical distribution, and genetics all play a part, though in varying order of importance, we decide upon species nomenclature.

The question then is whether a detailed examination from the above points of view justifies the merging of *purpurascens* and *punctatum* into the species *hirsutum*. Such an examination must make use of the criterion proposed but not employed by Hutchinson and Ghose (1937) when they say: "In devising a satisfactory classification for the species determined by genetic study, it is necessary to use only such characters as are indicative of fundamental differences in genetic composition."

About the *punctatum* group little will be said in this article, since more genetical information is required before discussing its taxonomic position. It is obviously related to both Uplands (*hirsutum*) and Bourbons (*purpurascens*), and Lewton (1912) thought it worth while to describe a characteristic member of this group as a separate species, *G. hopi* Lewton.

The use of the specific name *G. purpurascens* Poir. to denote the Bourbon group was adopted by the writer (1932) from Watt (1907). The drawing of *G. purpurascens* Poir. (No. 44 opposite p. 250) so closely resembled the typical Bourbons in the writer's collection, particularly in the calyx shape, number of bract teeth, narrow, cup-shaped flower, and boll shape, that it seemed the most convenient name to adopt, more especially since the general description of the species given by Watt also conformed. It was recognized that the Bourbon group was related to the Upland group, but how distantly was not known.

Subsequently, descriptions were made of as many morphological

TABLE 1.—GENETICAL DIFFERENCES BETWEEN PURPURASCENS AND HIRSUTUM

purpurascens		*hirsutum*	
Gene	Character	Gene	Character
Not known		R^H	Red leaf
R^P or R^B	Red leaf	Not known	
S^P	Petal Spot (mutable on *hirsutum* background).	Not known	
Not known		S^H	Petal spot.
Not known		G^{LH}	Green lint.
C^{OP}	Corky (complementary).	Not known	
t	Naked seed (recessive).	Not known	
Not known		T	Naked seed (dominant).

characters as possible, and it was found that the means of many of them were intermediate between *barbadense* and *hirsutum.* In other characters, more especially the time of bursting of the anthers and the features of the filaments, the Bourbons differed from both *hirsutum* and *barbadense.* Genetical studies of crosses between Bourbon and Upland have also been conducted by the writer since 1926 and have revealed that the genetical differences between these two groups are very considerable. The main ones are given in Table 1.

MODIFIER COMPLEX DIFFERENCES BETWEEN PURPURASCENS AND HIRSUTUM

1. The modifier complexes affecting "crinkled" are completely different in *hirsutum* and *purpurascens.* The gene for "crinkled" of *barbadense* was transferred to a typical *purpurascens* (*morrilli* Cook, and Hubbard) by several repeated backcrosses, and then isolated by selfing. When crossed with *barbadense* crinkled and *hirsutum* crinkled, respectively, it gave the following results in F_2:

(a) *purpurascens* crinkled × *barbadense* crinkled
Complicated series of forms from supercrinkled to pseudonormal.
(b) *purpurascens* crinkled × *hirsutum* crinkled
Complicated series of forms from crinkled to pseudonormal.

The variation in grade of crinkled in the *purpurascens-hirsutum* cross, although very considerable, was rather less than in the *barbadense-hirsutum* or *purpurascens-barbadense* series. This set of results is probably the most important of those yet available in deciding on the taxonomic position of *purpurascens,* and indicates such a specificity in the crinkled modifier complex as to confirm *purpurascens* in its position as a good taxonomic species, perhaps occupying a position intermediate between *barbadense* and *hirsutum* but nearer to the latter.

2. The fact that the petal spot gene S^P of *purpurascens* becomes reduced in intensity and becomes mutable, also indicates differing modifier complexes in *hirsutum* and *purpurascens.*

STERILITY IN CROSSES OF PURPURASCENS AND HIRSUTUM

Some sterility has been noted in the F_2 of *purpurascens–hirsutum* crosses. Such sterility is not to be expected between varieties assigned to the same species.

CHARACTER DIFFERENCES

Some character differences between *purpurascens* and *hirsutum* are worthy of note.

CHARACTER	PURPURASCENS	HIRSUTUM
Flower shape	Narrow cuplike	Widely expanded
Anthers—time of bursting	Late	Early
Number of bract teeth	Few	Many
Leaf shape	Mean L/S* of 2 5	L/S about 1 6–1 8
Kidney seed	Known but rare	Not known

* L/S = Length of leaf ÷ length to sinus

LEAF SHAPE

There are several allels for leaf-shape in *purpurascens*. The characteristic broad leaf of *hirsutum* is extremely rare in *purpurascens*, being present in one type only of 20 standard *purpurascens* types selected from widely differing localities.

BRACT TEETH

The mean number of bract teeth in *purpurascens* varies from 4.0 to 9.5 with a mean of 6.0 in the 20 types. This character appears to be of quite definite significance in *purpurascens*.

Table 2 shows the correlation diagram between leaf shape (L/S–

TABLE 2.—CORRELATION LEAFSHAPE AND NUMBER OF BRACT TEETH
20 Representative Bourbons

Leaf Shape L/S																				
3 4						112														1
3 3					114															1
3 2				230																1
3 1																				—
3 0																				—
2 9					12															1
2 8							50													1
2 7				161																1
2 6			158																	1
2 5			13		111		○													2
2 4			108						29											2
2 3					107	165		166		208										4
2 2																				
2 1														21						1
2 0									106 26											2
1 9						92														1
1 8												167							⊕	1
	3 0	3 5	4 0	4.5	5 0	5 5	6 0	6.5	7 0	7 5	8 0	8 5	9 0	9 5	10 0	10 5	11 0	11.5	12 0	
			3	2	4	3	1	1	3	1	—	1	—	1						

Mean number of bract teeth

The numbers in the squares refer to the type number in the World Collection
○ = Mean of Bourbon Group
⊕ = Approximate position of Upland.

length + length to sinus), and number of bract teeth in a representative group of Bourbons. The position of a representative *hirsutum* is marked, from which it will be seen that the distribution of all the Bourbons is clearly demarcated from *hirsutum*.

SUMMARY

Enough has been said to make it evident that the Bourbon group is distinct from the Upland group on both morphological and genetical grounds. In the writer's view, the assemblage of Bourbons is a good taxonomic species and is as distinct from Upland as, say, *arboreum* is from *herbaceum*. Bourbon should continue to be known as *G. purpurascens* Poir. pending a better name.

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ENTOMOLOGY.—*Some new species of Syrphidae* (Diptera).[1]

Frank M. Hull, University of Mississippi. (Communicated by E. A. Chapin.)

This paper describes some neotropical Syrphidae, some of which were collected by the author at Barro Colorado Island and others accumulated. Types are in the author's collection.

Mesogramma lyrata n. sp.

Male.—Length 6 mm. Head: Front and face pale yellow, cheeks black, antennae wholly pale orange, arista black on apical two-thirds. Vertex violet immediately behind the ocelli, brassy brown posteriorly. Thorax: With a median, bluish-gray, linear vitta outside of which it is very broadly brassy brown. Viewed from the rear there is sublaterally, above the complete yellow lateral margin, a light brown and then a dark brown vitta. Scutellum brownish yellow, diffusely darker brown upon the disk, its discal pile pale, its marginal pile black, the posterior part of mesopleurae and the upper part of sternopleurae pale yellow. Abdomen: Brownish orange, marked with

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[1] Received June 6, 1940.

dark brown. First segment yellow, with a pair of posterior, slender, black fascia separated in the middle, not reaching the sides. Second segment with a posterior, marginally evanescent, complete brown fascia, a quite evanescent incomplete subbasal fascia which shows traces of connection with the posterior one. Third segment with a slender subapical brown fascia curving up for a short distance along the posterior margin, also reaching the posterior corner and near the midline turning sharply upward to form a pair of outwardly turned, comma-like brown spots. Fourth segment with similar pattern but only the comma-like brown spots apparent. Fifth segment and hypopygium brownish orange. Legs: Pale yellow, the anterior tarsi orange, the posterior tarsi brownish, the hind femora and tibiae with subapical and subbasal blackish annulae respectively. Wings: Clear hyaline, stigma pale yellow.

Holotype.—Male. August 30, 1938, Barro Colorado Island (F. M. Hull collector).

Mesogramma basilaris Wd. var. **flavocuneus** n. var.

Female.—Length 6 mm. Head: Face yellow, a small obscure blackish spot beneath vertex violet; the front flat, smooth, metallic. The sides sharply marked with pale yellow almost to the ocelli. Cheeks black, antennae grayish brown, orange below. Thorax: With a wide, metallic gray, median vitta and a similar sublateral one. Between these vittae are others which are dark, golden-brown or brassy, and in some lights themselves appear to be divided. Scutellum metallic black, the posterior part of the rim narrowly yellow. Humeri, the posterior part of mesopleurae, and the upper part of sternopleurae yellow. Abdomen: Black marked with yellow, the first segment largely black, the anterior corners and a narrow anterior margin yellow, second segment black with a pair of small oval yellow spots, rather widely separated in the middle of the segment and a quite narrow lateral margin reaching nearly to the posterior corners also yellow. Third segment with a pair of widely separated yellow basal spots, which on their median ends are widely produced in a posterior direction to just past the middle of the segment and at the same time slightly curving toward the midline. These posterior ends are rounded and the lateral, basal portion of the spot reaches to the lateral margin of the segment where it is just a little expanded posteriorly. Fourth segment with almost identical pattern. Fifth segment somewhat similar, the lateral portions wider, the median portion about the same but the two spots more closely approximated. Legs: Pale yellow, the anterior tarsi pale brown, the hind tarsi and a prominent subapical annulus on the hind femora black. Hind tibiae with faint brownish black annulae on either side of the middle. Wings: Hyaline, stigma pale brown.

Types.—Holotype and three paratypes: Females. Salada River, near Ceiba, Spanish Honduras, September 2, 1938 (F. M. Hull collector). One additional paratype, female, from Tuxtepec, Mexico, in the U. S. National Museum.

Baccha flata n. sp.

Male.—Length 14 mm. Head: Face, cheeks, and front pale yellow, the front with a rhomboid, blackish spot of some size in the center, confluent with a smaller black spot just before the antennae and on each side of which are brownish triangles touching the eye margins. Pile of front and face erect, thick, and blackish, somewhat paler below. Antennae orange-brown, darker upon the upper part of the third joint, antennal pile black. Thorax: With four, dully shining, brassy black vittae upon a brownish-yellow background;

the sublateral vittae widest, interrupted at the suture; the submedian vittae connected at a spot opposite the suture and giving the impression of a narrow H. Between the several vittae the thorax is golden-pollinose. Thoracic pile thick, erect and dark brown, becoming reddish or yellow along the lateral margins of the mesonotum. Humeri and practically the whole of the pleurae, except for a tiny spot below the base of the wing, light yellow. Scutellum light yellow with a subtranslucent, transverse fascia. Abdomen: Chiefly brownish orange, flattened and spatulae, the first segment pale yellow except for a narrow posterior margin, the second segment with a narrow yellow posterior margin and a pair of prominent, hyaline, rectangular windows in the anterior corners. Third segment wholly orange except for a narrow subapical, narrowly attenuated black fascia, interrupted in the middle and not reaching the sides. Fourth segment similarly colored. Fifth almost wholly orange. Legs: Pale brownish orange, more yellow upon the anterior pair. Hind femora with thick, very long, shaggy, reddish pile and some black pile at its base and on hind trochanters and coxae. Wings: Hyaline, with a sharply marked brown band along the anterior margin.

Holotype.—Male, Petropolis, Brazil, March 1, 1914.

Salpingogaster halcyon n. sp.

Male.—Length 17 mm. Head: Cheeks and face and upper part of front pale yellow. Greater anterior portion of front is black, expanded triangularly to the sides and to the eye margin Antennae dark brown, first joint nearly black. Thorax: Obscurely shining black with three obscure, dark, reddish-brown vittae on the anterior two-thirds, and viewed from behind a more or less square area covered with pale yellowish-gray pubescence that is rather prominent. Pleurae black. The humeri, propleurae, notopleurae, a wide conspicuous oblique cuneiform stripe upon the posterior part of the mesopleurae, upper sternopleurae, anterior pteropleurae, and a second spot upon the anterior part of the metapleurae all pale yellow. Scutellum pale yellow with a transverse brown fascia not reaching the sides in the middle. Abdomen: Slender, with a prominent median black vittae from base of second segment to apex. First segment pale yellow with a diffuse light brown posterior margin. The anterior corners of the second segment and the narrow sides, as well as the somewhat wider sides of the third segment are pale yellow but diffuse. The apical portion of the sides of the third segment as well as the fourth segment reddish brown. Legs: Light yellow, the posterior tarsi, apical two-thirds of posterior tibiae, base and apical annulus of hind femora obscurely blackish or dark brown. Pile of anterior legs yellow, except on fore tarsi; black on the entire hind legs. Wings: Pale brown, strongly yellow on the basal half anteriorly, the stigmal cell very dark brown, the marginal cell somewhat lighter brown.

Holotype.—Male, Barro Colorado Island, August 28, 1938 (F. M. Hull collector).

ZOOLOGY.—*A new species of phyllopod crustacean from Stone Mountain, Georgia.*[1] EDWIN P. CREASER, U. S. Fish and Wildlife Service. (Communicated by WALDO L. SCHMITT.)

On June 8, 1939, I was informed by Don E. Eyles that certain fairy shrimps were occurring in rain pools on the summit of Stone Mountain in DeKalb County, Ga. Mr. Eyles had been requested to be on the watch for these crustaceans, as he was studying these pools and a few specimens new to science had previously been found at this location. Accordingly, on June 9, 1939, I climbed to the summit of the mountain, amid a rain and hail storm, and obtained a fine series of these phyllopods.

These crustaceans inhabited shallow rock pools 3 to 6 feet in diameter with fine silt bottoms, occurring in water not exceeding 4 inches in depth. They were found in company with a bloodworm (chironomid larva?) and a species of *Eulimnadia* (Phyllopoda: Conchostraca), which is possibly also undescribed and which is being studied by Prof. J. G. Mackin. These phyllopods prove to belong to the genus *Chirocephalus*, another species of which is widespread throughout Europe. The genus has not previously been recorded from North America. The species, *Chirocephalus lithacus*,[2] is here described for the first time.

Dr. A. S. Pearse very kindly arranged the loan of some microscopic equipment needed during the course of this study.

BRANCHIPODA

PHYLLOPODA: ANOSTRACA

Family CHIROCEPHALIDAE

Chirocephalus lithacus, new species

Description.—Male: Total body length of adult, 8.3 to 10.5 mm. Frontal appendage rising from middle of head as a single organ, then dividing into two similar branches, each branch in turn terminating in two lateral branches, one of which is club-shaped and armed at apex with a stout spine and studded over entire surface with papillae of probable sensory nature; the other branch laminate, with fingerlike weak spines along margins. Each branch of frontal appendage about 3 mm long. Clasping antenna sickle-shaped; basal article half length of terminal article. Inner margin of terminal article with fine oblique grooves. First antennae shorter than terminal article of clasping antennae. Eyes stalked, with greatest diameter less than 0.5 mm. Abdominal segments consisting of genital-bearing segment, 7 post-genital segments, and cercopods. Cercopods uniformly tapering, with setae of approximately one-fourth total length of cercopod. Swimming appendages with one branchial lamina.

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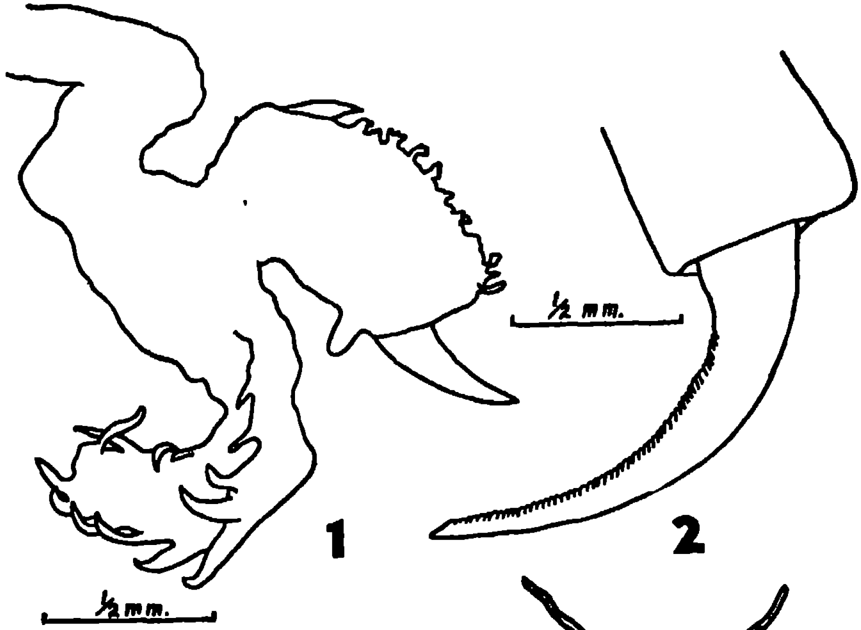
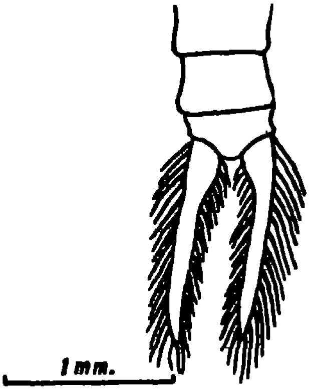
[1] Received June 5, 1940.

[2] The name *lithacus* was suggested for this animal by Dr. Carl L. Hubbs. Translated from the Greek, it means of a stony place.





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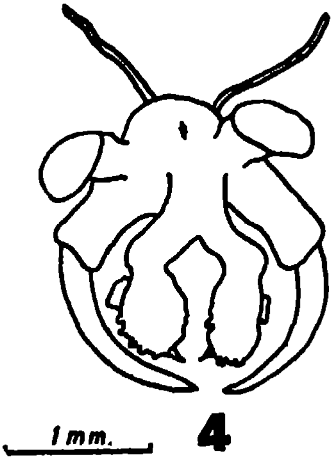

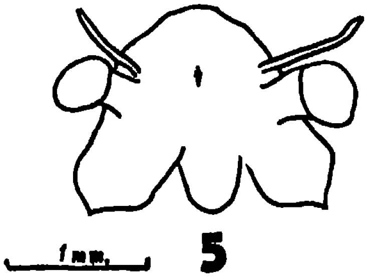

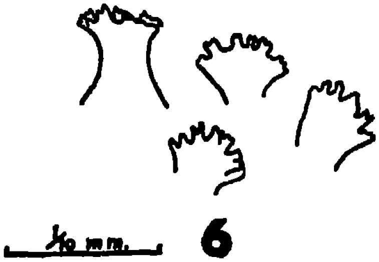

Fig. 1.—Frontal appendage. Fig. 2.—Clasping or second antenna of male. Fig. 3.—Male cercopods. Fig. 4.—Front view of head of male. Fig. 5.—Front view of head of female. Fig. 6.—Papillae of frontal appendage of male.

Female: Total body length of adult, 10.5 to 11.1 mm. Frontal appendage absent. First antennae about as long as clasping antennae. Clasping antennae flattened, pointed at apex, uniformly rounded on margins. Eyes stalked, with greatest diameter less than 0.5 mm. Ovisac one-half as long as abdomen with cercopods excluded. Ovisac gourd-shaped, not uniformly tapering, with apex turned abruptly toward the abdomen. Cercopods uniformly tapering, with setae of approximately one-fourth total length of cercopod.

Remarks.—This species may be distinguished from other North American phyllopods by the shape and structure of the bilaminate male frontal appendage and by the sickle-shaped appearance of the clasping antennae

Types.—I collected the types of this new species in temporary pools in the granite rock on the summit of Stone Mountain, DeKalb County, Ga., within 100 yards of the airway beacon, June 9, 1939. They have been deposited in the United States National Museum: Holotype male, no. 79294; allotype female, no. 79295.

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ZOOLOGY.—Cercaria pricei, *a new trematode, with remarks on the specific characters of the "Prima" group of Xiphidiocercariae.*[1]

Miriam Rothschild, London, England. (Communicated by E. W. Price.)

It is not an unusual phenomenon to discover several very closely related species of larval trematodes parasitizing the same host. *Cercaria pricei* n. sp., described in this paper, is the third species of the "Prima" subgroup of Cercariae ornatae (Lühe, 1909) to be found in the snail *Pseudosuccinea columella* Say. Although this type of cercaria was originally recorded from Europe, almost all the important experimental work on their life histories has been carried out in brilliant fashion by Krull (1931, 1933) and other workers in the United States.

The individual author's spelling of host names is used herein. Furthermore the generic and specific names of the adult fluke used by the author in his description of its cercaria and life history are retained to avoid confusion.

I should like to express my gratitude to Dr. E. W. Price for his kindness in affording me every facility for work during my unexpected visit to Washington at the outbreak of the European war, to the Spen-

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[1] Received June 3, 1940.

cer Lens Company for lending me superlative microscopical apparatus and to Dr. J. P. E. Morrison and Countess Mary Roberti for assisting in the collection of specimens.

CHARACTERS OF THE "PRIMA" SUBGROUP OF CERCARIAE ORNATAE

Sewell (1922) recognized that certain species of "Ornatae" Xiphidiocercariae formed a compact natural group of which *Cercaria prima* Sinitzin, 1905, was selected as the "type." Sewell's definition can be emended on several unimportant points. He regarded only the stem of the Y-shaped excretory bladder as the bladder proper and described the crura as dilatations of the excretory tubes. The subsequent development of the bladder in the metacercaria shows that this is erroneous. Two species with six pairs of penetration glands have also been discovered since 1922.

McMullen (1937) has shown that the presence or absence of a tail fin-fold may not be a character of great importance when forming a natural classification within a large group like the Plagiorchioidea. With this opinion I am in entire agreement. In the matter of tail structure and modification or loss of fins there is repeated evidence of parallel evolution in distantly related genera within one superfamily.[3] McMullen writes:

> In the cercariae of the frog lung flukes and related forms a similar situation arises. The cercariae of these trematodes . . . all have a fin-fold on the tail except the cercaria of *Haplometra cylindracea*. Here the absence of the fin-fold would, in the present classification, eliminate this form from the Ornatae group of Xiphidiocercariae and thus separate it from closely related forms. It seems probable, therefore, that the fin-fold of the tail and other such larval modifications are of little more than specific value in the Xiphidiocercariae

However, the adult forms of "Prima" cercariae have all proved to be frog lung flukes of the subfamily Haematoloecinae Freitas and Lent, 1939 (=Pneumonoecesinae Mehra, 1937). *Haplometra cylindracea* Zeder is not in my opinion closely related to this subfamily, and in the opinion of Mehra (1937) it pertains to another family altogether. The absence of a tail membrane in this cercaria is therefore not considered to have any special bearing on the subgroup now under consideration, and the presence of a "Prima" type of fin-fold is for the present retained as a diagnostic character.

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[3] Another type of parallel evolution to be found in the tail structure of cercariae is worthy of note. This may be typified by the giant tails found in unrelated cercariae which are swallowed as free swimming organisms by fish, for example, *Petasiger nitidus* Linton, 1928 (Echinostomidae) and *Proterometra macrostoma* (Faust, 1918) (Azygiidae).

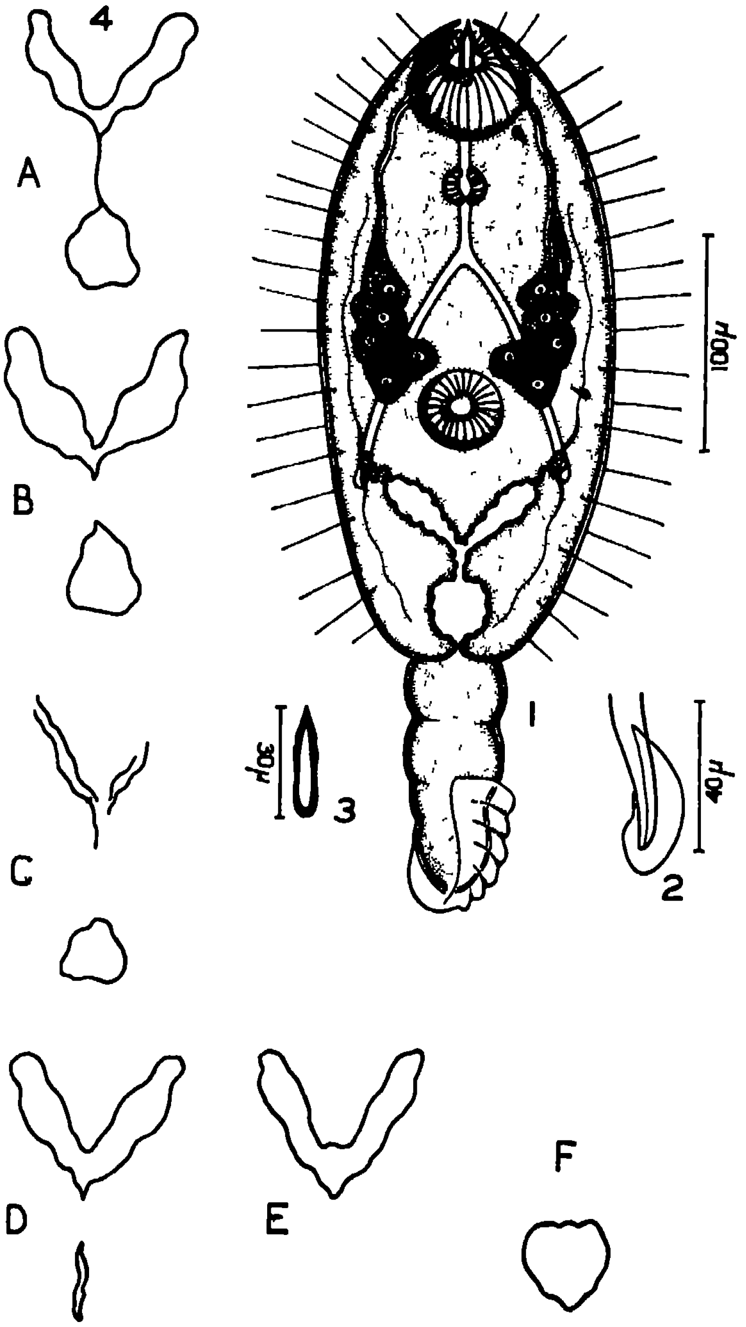

Fig. 1.—Diagram of *Cercaria pricei* from ventral aspect with tail contracted (penetration glands shown slightly larger than in reality. Fig. 2.—Fin-fold under pressure of a coverslip. Fig. 3.—Stylet. Fig. 4.—A–F, Diagrams showing appearance of excretory bladder during different stages of contraction.

THE "PRIMA" SUBGROUP SEWELL, 1922 (EMENDED)

(1) Distome Xiphidiocercariae of medium size in which the acetabulum is situated behind the middle of the body length.

(2) The tail is shorter than the body and is furnished with a dorsoventral fin-fold in its distal portion; the ventral portion of the fin extends farther forward than the dorsal portion.

(3) The alimentary canal possesses a prepharynx and a pharynx, and the intestinal caeca reach back to a point between the margin of the acetabulum and the posterior end of the body.

(4) Four to six pairs of penetration gland cells are present.

(5) The excretory bladder is Y-shaped and does not extend beyond the lateral margins of the ventral sucker. The main excretory tubes enter the bladder at the extremity of the arms of the Y. They divide into anterolateral and posterolateral branches at the level of the ventral sucker. The excretory pattern is $2[(1+1+1)+(1+1+1)]=12$ or $2[(3+3+3)+(3+3+3)]=36$.

(6) Development occurs in small unbranched sporocysts.

(7) The first intermediate hosts are fresh-water gastropod mollusks, and the second intermediate hosts are arthropods.

Thirteen species may with certainty be included in this group:

Cercaria prima Sinitsin, 1905.
Cercariae indicae XXIV Sewell, 1922.
Cercariae indicae XXVIII Sewell, 1922.
Cercaria longistyla McCoy, 1929.
Cercaria prima Dubois, 1929 (*nec* Sinitsin, 1905).
Cercaria of *Pneumonoeces medioplexus* (Stafford, 1902) Krull, 1931.
Cercaria of *Pneumobites parviplexus* (Irwin, 1929) Krull, 1931.
Cercaria prima Wesenberg-Lund, 1934 (*nec* Sinitsin, 1905, *nec* Dubois, 1929).
Cercaria of *Haematoloechus complexus* (Seely, 1906) Krull, 1933.
Cercaria of *Ostiolum oxyorchis* (Ingles, 1932) Ingles, 1933.
Cercaria herberi McMullen, 1938.
Cercaria merchanti Rankin, 1939.
Cercaria pricei n. sp.

Of these species *C. prima* Wesenberg-Lund was examined from a crushed snail only, a fact that undoubtedly accounts for the undeveloped state of the intestinal caeca. From time to time various species such as *Cercaria pela* Porter, 1938, *C. elemensis* Porter, 1938, and *C. laticauda* Wesenberg-Lund, 1934, have been erroneously assigned to this subgroup. These larvae generally display features that place them in Lühe's Cercariae ornatae but that exclude them from the circumscribed "Prima" subgroup. There are certain other species, such as *Cercaria ornata* Lutta, 1934 (*nec* La Valette, 1855), *Cercaria pratensis* Skwortzoff, 1924, and *Cercaria prima* Ruszkowski, 1925 (*nec* Sinitsin, 1905), whose exact systematic position must remain doubtful until more adequate descriptions are available.

TABLE 1.—DATA ON 13 SPECIES OF CERCARIA IN THE "PRIMA" GROUP

Species of Cercaria	First intermediate hosts	Second intermediate hosts	Number of penetration gland cells (pairs)	Size of stylet
Cercaria prima Sinitsin, 1905	*Aplexa hypnorum*, *Planorbis vortex* var *compressa*.	Larvae of *Corethra* and *Ilybius* (Ephemeridae)	5	25μ in length.
Cercariae indicae XXIV Sewell, 1922	*Limnaea succinea*.	Unknown.	4	?
Cercariae indicae XVIII Sewell, 1922	*Limnaea acuminata*.	Unknown.	4	0.028 mm.
Cercaria longistyla McCoy, 1929	*Physa integra*, *P* *anatina*.	Dragonfly larva, small water insects.	5	32 by 4μ.
Cercaria prima Dubois, 1929 (nec Sinitsin, 1905)	*Aplexa hypnorum*, *Lymnaea palustris*	*Asellus aquaticus*	4	20–33μ long, 4.5–6μ wide.
Cercaria of *Pneumonoeces medioplexus* (Stafford, 1902)	*Planorbula armigera* (Say).	*Sympetrum obtrusum* (Hagen), *S. rubicundulum* (Say)	6 (probably)	17.5μ by 2.26μ.
Cercaria of *Pneumobites parviplexus* (Irwin, 1929)	*Gyraulus parvus* (Say)	*Sympetrum obtrusum* (Hagen), *S* *rubicundulum* (Say)	5 (probably)	19.9μ in length.
Cercaria prima Wesenberg-Lund, 1934 (nec Sinitsin, 1905; nec Dubois, 1929)	*Planorbis albus*	Unknown.	4	No measurements of fully developed cercaria.
Cercaria of *Haematoloechus complexus* (Seely, 1906)	*Pseudosuccinea columella* Say.	*Sympetrum vicinum*, *Pachydiplax longipennis*, *Holotania* (*Libellula*) *incesta*, *Chromagrion conditum*, *Enallagma divagans*, *Lestes vigilax*, *Tetragoneuria cynosura* Say, *Argia* sp	5	30μ average length, 5μ average width.
Cercaria of *Ostiolum oxyorchis* (Ingles, 1932)	*Planorbis* (*Gyraulus*) *parvus* Say, *Planorbis* (*G*) *vermicularis* Gould	*Plathemis lydia* (Drury), *Sympetrum illotum* (Hagen)	7	22μ in length.
Cercaria herberi McMullen, 1938	*Physella magnalacustris* (Walker)	Mosquito larvae, Dragonfly naiads.	6	0 034 mm (length).
Cercaria marchanti Rankin, 1939	*Pseudosuccinea columella* Say	Dragonfly nymphs, Damselfly nymphs.	5	0 04 by 0 004 mm
Cercaria pricei n. sp.	*Pseudosuccinea columella* Say	Unknown.	5	30–34μ by 4.2–5.1μ

SPECIFIC CHARACTERS OF THE "PRIMA" SUBGROUP

Judged from the descriptions by such excellent observers as Krull and Sewell it is only a little less difficult to distinguish between these larvae than certain heterophyid, notocotylid, and microphallid cercariae. Up to a point the same difficulties are encountered as those indicated for Opisthorchioidea cercariae (Rothschild, 1938). Measurements of soft parts can only be regarded as supplementary data, although in some cases the discrepancy in size is so great that it can not be due to difference in the technique adopted by individual observers. Measurement of the stylet is, however, of much importance. As in other groups, the relative degree of development and transparency of certain organs, such as sensory setae, cuticular spines, intestinal caeca, reproductive anlage, etc., are specific differences that do not lend themselves well to written descriptions. Perhaps one of the most tantalising characters of this type is the relative thickness or toughness of the cuticle. The cercaria of *Pneumobites parviplexus*, for example, fragments after a few seconds under a coverslip, whereas *C. pricei* n. sp. remains intact for many hours. This is no doubt an extreme case, but in comparing cercariae almost every worker comes across subtle differences of this type that, although very obvious, can not be accurately described and at times even defy analysis.

The number and arrangement of penetration glands can vary specifically, but as the range is small this may not be very helpful (Table 1). The ducts apparently can open at the base or the tip of the stylet (*C. indicae* XXVIII, *C. indicae* XXIV). The shape and color of the parthenitae, together with the number of cercariae maturing simultaneously within each sporocyst, also vary specifically, but the age of an individual infection and the temperature of the water (Rothschild, 1935) appear to exert some influence upon these characters. Two different excretory patterns are met with. In one the full complement of flame cells found in the adult fluke is already developed, and in the other each group is represented by one flame cell only. No more than three patterns have been completely worked out. The distribution of sensory setae may be of much importance, but apparently in many cases these structures are not visible to the ordinary observer. Sinitzin undoubtedly possessed superior eyesight and described them in wonderful detail for nearly all his cercariae. The accuracy of his observations is verified from time to time when a species is found in which they are more obvious than in others.

TABLE 2.—BEHAVIOR OF CERCARIA

Species of Cercaria	Time of emergence from snail host	Duration of free swimming life	Tropisms	Other characteristics
Cercaria of *Ostiolum oxyorchis* (Ingles)	Afternoon and night.	About 24 hours.	No reaction to light or darkness.	Swim at all levels of water.
Cercaria of *Haematoloechus complexus* (Seely)	Throughout day.	?	?	
Cercaria of *Pneumobites parviplexus* (Irwin)	During afternoon.	?	No heliotropic response	Uniformly distributed throughout water except in cool of morning, when swims sluggishly near bottom of container
Cercaria of *Pneumonoeces medioplexus* (Stafford)	Chiefly during night	?	Do.	Do
Cercaria herberi McMullen	?	?	?	Good swimmer
Cercaria marchanti Rankin	?	?	Positively phototropic; negatively geotropic; some response to shadow	Rapid and constant swimmer.
Cercaria indicae XXIV Sewell	?	?	?	Somewhat feeble swimmer.
Cercaria pricei n. sp.	Throughout day	About 9 hours (at room temperature in tap water).	No response to light or shadow Occasionally swarm around objects in water	Swims at all levels of water. Frequently dies fixed and flattened against sides of container.

Specific descriptions of "Prima" cercariae can be based on the following characteristics

- (1) Size
  - (a) Relative length of body and tail
  - (b) Relative size and position of suckers, pharynx,[3] prepharynx, and esophagus
- (2) Shape and dimensions of stylet (see Table 1)
- (3) Precise extent and shape of caudal fin-fold
- (4) Behavior (see Table 2)
  - (a) Time of emergence from the snail host
  - (b) Duration of free swimming life[4]
  - (c) Tropisms
  - (d) Choice of second intermediate host (including negative data)
- (5) Cyst
  - (a) Shape (see Dubois, 1929, p 56)
  - (b) Size
  - (c) Location

Supplementary characters

- (6) Excretory pattern
- (7) Number of penetration gland cells
- (8) Distribution of sensory setae
- (9) Presence of sensory papillae
- (10) Sporocysts
  - (a) Shape
  - (b) Color
  - (c) Number of cercariae maturing simultaneously within each sporocyst

It is probable that these characters are valid for differentiating between other subgroups of Cercariae ornatae such as the "Hemilophura" subgroup These differ essentially from "Prima" cercariae in the possession of an I-shaped excretory bladder, a fin-fold extending along the whole or two-thirds of the ventral side of the tail but not along the dorsal side, and elongated "worm"-shaped sporocysts Variation in behavior has also been noted The cercaria of *Macroderoides typicus* emerged "in the mid-morning hours and died within a few hours" (McMullen, 1935), whereas the cercariae of *Haplometrana utahensis*, "are shed throughout the day and night with the greatest numbers appearing towards the evening and lived as long as 40 hours" (Olsen, 1937)

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[3] The conspicuously large pharynx of the cercaria of *Ostiolum oxyorchis* is also a feature of the adult fluke

[4] The term "duration of free swimming life' I understand to mean the period during which the cercaria is capable of swimming in the water after natural emission from the snail host (Rothschild 1938), and not the period during which the cercaria manifests movement or "signs of life" In most instances the latter character does not lend itself so well to accurate and clear cut comparison (Dubois, 1929), although it is useful as supplementary data (Wheeler, 1939)

Cercaria pricei,[3] n. sp. Figs. 1–4

Description.—Xiphidiocercaria of the "Prima" type, with the characters of the group. Measurements in microns (under light pressure of coverslip): Body length 375 to 257, mean 327; width 149 to 107, mean 135. Tail length 232 to 166, mean 200; width 49 to 41, mean 45. Fin 41 long ventrally, 22 dorsally; maximum width 17. Oral sucker 68 by 68 to 51 by 51, ventral sucker 44 by 51 to 31 by 41. Pharynx 25 by 22, prepharynx length 11.9 to 15.3; esophagus length 25. Stylet 30 to 40 by 4.2 to 5.1. Sporocyst (maximum) 249 by 124.

Body regularly oval in outline. Tail when extended two-thirds length of body, when contracted one-half length of body. Ventral sucker slightly more than half diameter of oral sucker, situated somewhat less than two-thirds of body length from anterior extremity. Esophagus short, barely longer than pharynx. Intestinal caeca well developed Five pairs of penetration gland cells of which the posterior three pairs are coarsely granular, slightly larger, and dorsal to the two anterior pairs. Ducts of glands arranged in two groups opening near anterior extremity of stylet. Crura of bladder not reaching posterior border of ventral sucker. Cuticle faintly rugose, without spines or sensory tubercles. Two rows of long sensory setae along lateral edges of body, arranged as in *C. prima.* Parthenitae stumpy, sausage-shaped, pale yellow; one to two cercariae maturing simultaneously within each sporocyst.

Behavior.—The cercariae emerge throughout the day, the length of free swimming life being nine hours in tap water at room temperature.

No phototropic responses.

First intermediate host.—*Pseudosuccinea columella* Say.

Locality and date of collection.—Shaw Lily Gardens, Washington, D. C., September-October, 1939.

Remarks.—*Cercaria pricei* most closely resembles the Cercaria of *Haematoloechus complexus* described by Krull and *Cercaria merchanti* described by Rankin, both from the same host It can be separated from the former by its much greater size, number and arrangement of sensory setae, the relatively shorter prepharynx, and greater distance between the fork of the intestine and the ventral sucker. In *C. merchanti* the forks of the Y-shaped bladder extend to the lateral borders of the acetabulum; the long sensory setae are absent but sensory tubercles are present around the oral sucker; the stylet is narrower in comparison with its length; and there are also differences in behavior (see Table 2).

One of the most striking features of *C. pricei* is the periodic contractions of the bladder. First the cavity of the stem is obliterated and then the branches of the Y. This curious phenomenon is not mentioned by either Krull or Rankin, but Ingles (1933) has noted it for the Cercaria of *Ostiolum oxyorchis*, and Miller (1935) and Dubois (1929) record it for "Polyadena" cercariae. Krull's drawing of the bladder of the Cercaria of *H. complexus* does not entirely agree with the description, and in fact the bladder figured for *Cercaria tricystica* Miller, 1935, *C. helvetica* V Dubois, etc., more closely resembles that of *C. pricei* than several of those figured for "Prima" cercariae!

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[3] Named for Dr. E. W. Price, of the U. S. Bureau of Animal Industry, in honor of his many contributions to our Knowledge of the Trematoda.

It has already been mentioned that the ducts of the penetration glands are arranged in bundles They are so closely approximated that anterior to the esophagus there appear to be only two ducts and two apertures on each side. It sometimes happens that one of the posterior pairs of glands, which are situated dorsally, presents the finely granular appearance characteristic of the anterior ventrally situated pairs (see also Sewell, 1922, p. 222). A large spherical nucleus and prominent nucleolus are conspicuous in each penetration gland cell.

Unlike *C. merchanti*, *C. pricei* does not collect on the lighted side of the vessel and in fact shows no phototactic responses whatsoever. At times it manifests a definite tendency to accumulate near the surface. At other times, however, the cerceriae remain distributed at all levels of the water or segregate in the lower levels. It seems probable that the nature of their geotropic response is correlated with temperature changes as suggested by Krull (1931) for cercariae of *P. medioplexus* and *P. parvıplexus* *C pricei* swims continuously from the time of emergence, with occasional momentary pauses when the body is suddenly extended horizontally. There is also a slight tendency to swarm around small objects in the water, particularly the snail host, but this again seems to depend on certain unknown factors, as it is manifested on some days and not on others.

One very peculiar habit is typical of this cercaria. A fairly large number were kept in glass tumblers, and while swimming they quite frequently came into contact with the sides of the vessel. They then attached themselves and crawled about on the glass by the usual "leeching" movements. At death they did not drop off and fall to the bottom of the container but became fully extended and remained flattened against the glass like a series of permanent preparations. Water beetles, dragonfly nymphs, and other insect larvae were fished from the same pond and introduced into the jars with the cercariae, but penetration was not observed.

EFFECT ON THE SNAIL HOST

The effect of trematode parasites on the ultimate size and growth rate of the molluscan host and the shape of its shell is probably far more universal than is generally recognized. Kelly (1899) apparently first drew attention to this phenomenon in the United States when he recorded change of shell shape in Unionidae due to castration by *Bucephalus* cercariae. He writes:

> From the shape of the shells eight of these thirty-one individuals (infected with cercariae) were pronounced males and two females. Others, also belonging to species in which the shells of the two sexes are normally characteristic, had shells of such shape as to render the sex problematical and to suggest that infestation by *Bucephalus* or other cercariae, when early acquired and

long continued, may so alter the form of the shell of the female as to cause it to resemble that of the male or, if acquired later, may produce an intermediate form.

Rankin (1939) found slight abnormalities of the shell of *Pseudosuccinea columella* infected with echinostome cercariae, but "little or no effect on the snail host from infection with Xiphidiocercariae was observed."

The snails harboring *C. pricei* n. sp. were collected from a tiny isolated pond about 4 by 3 feet, the surface of which was entirely covered with vegetation. A certain number of relatively large specimens of *P. columella* were found resting on the upper side of waterlily leaves, exposed to direct sunshine even during the hottest period of the day (100° F. in the shade). All these proved to be infected with Xiphidiocercariae. No uninfected snails were found in this unprotected situation; there was thus a marked difference in the behavior of parasitized snails.

It is believed that all the mollusks[6] present in this pond were collected and examined. Only those that could have passed through a fine-mesh sieve might have escaped notice. The mean height of uninfected *P. columella* was 3 mm, the maximum size being 4 mm. Infected specimens reached 10 mm in height, with a mean of 9.75 mm. It is not suggested that parasitism is responsible for this great contrast in size, but it might well prove a contributing factor. Without a fairly prolonged study of the snail population of any given area it would be impossible to come to any definite conclusion on this point.

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[6] Four species, all of which were identified by Dr. J. P. E. Morrison, to whom I tender my best thanks.

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PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE ACADEMY

361ST MEETING OF THE BOARD OF MANAGERS

The 361st meeting of the Board of Managers was held at the Cosmos Club on Friday, May 24, 1940. There were 20 present as follows:

E. C. Crittenden
F. D. Rossini
F. C. Kracek
H. S. Rappleye
J. H. Hibben
G. Steiner
F. M. Setzler
A. T. McPherson
A. Wetmore
C. Thom
W. A. Dayton
P. C. Whitney
H. L. Curtis
W. Ramberg
E. W. Price
R. R. Spencer
C. L. Garner
C. L. Gabin
W. W. Diehl
and by invitation
J. H. Kempton

Acting upon instructions from the Board, President Crittenden appointed the following committees:

(1) To consider societies qualified for affiliation with the Academy: F. M. Setzler, chairman; R. E. Gibson and R. R. Spencer, members.

(2) On awards for scientific achievement: A. H. Clark, general chairman; Physical Sciences, O. R. Wulf, chairman; Engineering Sciences, F. M. Defandorf, chairman; Biological Sciences, A. H. Clark, chairman. The other members of these committees are to be appointed later.

(3) To conserve the archives of the Academy: N. R. Smith, chairman; F. D. Rossini, member.

The following persons, whose names were presented to the Board by the Committee on Membership, were elected to membership:

Resident Members

Olaf Sverre Aamodt, principal agronomist, in charge of the Division of Forage Crops and Diseases, U. S. Bureau of Plant Industry, in recognition of his work on cereal pathology, particularly with respect to breeding for disease resistance, and also of his studies on forage grasses and legumes.

James Kenneth Ableiter, senior soil technologist, Division of Soil Survey, U. S. Bureau of Plant Industry, in recognition of his work in land-use planning and in productivity ratings of mineral soils.

Charles Walter Bacon, physiologist, Division of Tobacco and Plant Nutrition, U. S. Bureau of Plant Industry, in recognition of his contributions to various aspects of the physiology of tobacco plants, nutrition, etc.

Mark Baldwin, senior soil scientist, Division of Soil Survey, U. S. Bureau of Plant Industry, in recognition of his outstanding work on the genesis and classification of soils and on the coordination of federal and state soil surveys.

Edward Eastman Clayton, senior physiologist, Division of Tobacco and Plant Nutrition, U. S. Bureau of Plant Industry, in recognition of his contributions on the diseases of tobacco and other plants.

Paul Sydney Conger, research associate, Carnegie Institution of Washington, and custodian of diatoms, U. S. National Museum, in recognition of his studies on diatoms and their economic use and his discovery of important commercial deposits of diatoms in Wisconsin.

Henry Trendley Dean, dental surgeon, Division of Infectious Diseases, National Institute of Health, in recognition of his work on the relationship of fluorine to dental caries.

Samuel Leonard Emsweller, principal horticulturist, in charge of Floriculture and Ornamental Horticulture Plant Investigations, Division of Fruit and Vegetable Crops and Diseases, U. S. Bureau of Plant Industry, in recognition of his contributions to horticulture and the cytology and genetics of ornamental plants.

Earl Steinford Johnston, assistant director, Division of Radiation and Organisms, Smithsonian Institution, in recognition of his studies on radiation in connection with plant life.

Charles Edwin Kellogg, principal soil scientist and chief of the Division of Soil Survey, U. S. Bureau of Plant Industry, in recognition of his work on the genesis and classification of soils and on rural land-use planning.

Constantin Nikiforoff, soil scientist, Division of Soil Survey, U. S. Bureau of Plant Industry, in recognition of his work on dynamic processes in soils, on frozen soils of Siberia, on desert types of soil formation, and on the great soil zones of western North America.

Glenn Lane Parker, chief hydraulic engineer and chief of the Water Resources Branch, U. S. Geological Survey, in recognition of his work in hydrology, particularly on water power and snow surveys in the Cascades and on water resources as related to placer mining.

Eugene Alfred Siegler, pathologist, Division of Fruit and Vegetable Crops and Diseases, U. S. Bureau of Plant Industry, in recognition of his contributions to phytopathology, particularly his researches on crown gall.

James Thorp, soil scientist, Division of Soil Survey, U. S. Bureau of Plant Industry, in recognition of his work on the study and classification of the soils of China.

Jacob Osborn Ware, senior agronomist, Division of Cotton and other Fiber Crops and Diseases, U. S. Bureau of Plant Industry, in recognition of his work in cotton breeding and genetics and his contributions to agronomy.

Nonresident Members

Eubanks Carsner, senior pathologist, Division of Sugar Plant Investigations, U. S. Bureau of Plant Industry, Riverside, Calif., in recognition of his work in the field of virus diseases in plants.

John Nathaniel Couch, professor of botany, University of North Carolina, Chapel Hill, N. C., in recognition of his contributions to mycology, particularly on the genus *Septobasidium*.

Gordon Enoch Gates, professor of biology and head of the Department of Biology, Judson College, Rangoon, Burma, India, in recognition of his special researches on terrestrial oligochaetes.

Moses Ben Naphtali Levine, pathologist, Cereal Disease Investigations, U. S. Bureau of Plant Industry, University Farm, St. Paul, Minn., in recognition of his work on cereal rusts and smuts, on physiologic specialization and generic nature of rust pathogenes, and on environment and predisposition of grain crops.

Maurice Blood Linford, pathologist, Experiment Station, Pineapple Producers Cooperative Association, Honolulu, Hawaii, in recognition of his work in plant pathology, especially his studies on diseases of peas and pineapples, on plant-parasitic nematodes, on nematode biology and populations, and on natural enemies of nematodes.

Arthur Sperry Pearse, professor of zoology, Duke University, Durham, N. C., in recognition of his researches in zoology and ecology.

Lowell Fitz Randolph, chief in research, New York Experiment Station, Geneva, N. Y., in recognition of his work in cytology of chlorophyll types in maize, morphology of developing kernel in maize, chromosomes in maize and related genera, and induced polyploidy in maize and other plants.

William Jacob Robbins, director, New York Botanic Garden, and professor of botany, Columbia University, New York, N Y., in recognition of his work on plant nutrition, on enzyme secretion by fungi, on tissue culture with higher plants, and on growth substances.

Elvin Charles Stakman, professor of plant pathology, University of Minnesota, and agent of the U. S. Department of Agriculture, University Farm, St. Paul, Minn., in recognition of his contributions to phytopathology particularly on rust diseases of cereals.

James Zetek, associate entomologist, U. S. Bureau of Entomology and Plant Quarantine, and director, Barro Colorado Island Biological Laboratory, Institute for Research in Tropical America, Balboa, Canal Zone, in recognition of his researches in entomology, his services as a consultant in entomology to certain Latin-American republics, and his management of the Barro Colorado Island Laboratory.

Percy White Zimmerman, plant physiologist, Boyce Thompson Institute for Plant Research, Yonkers, N. Y., in recognition of his work in plant physiology.

The Committee on Revision of the Bylaws, H. L. Curtis, chairman, C. Thom and P. C. Whitney, members, recommended the following statement on the ballot to be issued on the restoration of the offices of nonresident vice-presidents:

In December 1939 the Academy adopted certain amendments to its bylaws, one group of which had for its purpose the elimination of the two nonresident vice-presidents of the Academy The section of the bylaws dealing with amendments provides that any three members of the Academy can propose an amendment and that the Board of Managers shall submit this proposal to the members before the next annual meeting. The Board received a petition on January 17, 1940, signed by six members, proposing changes to the newly adopted bylaws, the purpose of which is to restore the two non-resident vice-presidents Petitioners claim that the provision of two non-resident vice-presidents as members of the Board of Managers is a proper representation of the nonresident members of the Academy As required by the bylaws, the Board of Managers submits the following to the Academy for action:

Amend Article 2, Section 1, by inserting in the fourth line, "and two vice-presidents chosen from nonresident members." Article 2, Section 3, insert "resident" before vice-president in the fifth line Article 5, Section 1, insert in the fifth line after the word president "two persons for the nonresident vice-presidents "

In favor of amendment ________

Opposed to amendment ________

To be valid, all ballots must be received by the Secretary within two weeks from date at which they were mailed

It was moved and carried that this proposed amendment, with the preceding statement of explanation, be submitted for balloting by letter to the members of the Academy at the time of the distribution of the notices for the next regular meeting of the Academy.

The Corresponding Secretary announced the following deaths:

Cyrus Adler
Thomas A. Groover

The Board adjourned at 9:42 p.m.

BOTANICAL SOCIETY

295th meeting

The 295th regular meeting was held in the assembly hall of the Cosmos Club, February 7, 1939, President Charles Thom presiding; attendance 95. K. D. Doak, Haig Dermen, and Daniel Ready were elected to membership.

Notes and reviews.—M. B. Waite called attention to the winter injury that had occurred on the bamboos growing near the Henderson castle and also on Japanese honeysuckle. He believed this was due to the weather at Thanksgiving time when, after a heavy rain, the temperature fell to 17° followed by snow and sleet. He also displayed a very old book, Twaite's *Early western travels*, vol. 3, 1748–1846, which contains "The Travels of André Michaux."

Program.—G. F. Gravatt: *Effect of epidemic tree diseases on the food supplies of animals* (lantern).—Chestnut blight, *Phytophthora* root rot of *Castanea* species, *Cephalosporium* wilt of persimmon, a nectria disease of beech, and willow diseases, which threaten American forests and woodlands, are examples of rapidly spreading, supposedly introduced diseases that reduce materially food supplies of wildlife. Diseases reducing winter foods are most serious. One minor objective of the chestnut breeding and selection program is a strain combining small nuts, productiveness, and resistance to blight, which has destroyed nearly all commercial chestnut growth. Species that replace those killed may supply considerably less wildlife food. Even though white-pine seeds are not of outstanding value as wildlife food, the introduced white-pine blister rust has changed the food habits of some wildlife. When food is scarce some animals eat the young blister rust cankers; and other wildlife probably find species replacing *Ribes* eradicated to protect white pines no less valuable as sources of summer food. Diseases that do not kill whole trees may also decrease the food supply of wildlife. Probably our forests have so far been exposed to relatively few of the tree-disease organisms of other continents.

Father Arthene du Tilly: *Botanical exploration in the Canadian Arctics* (lantern).—Father du Tilly paid a tribute of admiration and gratitude to his predecessors in the exploration and conquest of the Arctic. Touching rapidly on the habitat of the Eskimos, he gave more consideration to the Arctic flora, showing its supreme importance in the life of men and animals, since both live mainly on plants. He compared this vegetation to that of the deserts and explained their physiognomic differences by conditions incident to sunlight, water, wind and snow. He told of the edible roots and berries, the medicinal properties of the greens, the different lichens used as fuel or food and fodder for animals; also of plants which by their variety and richness of coloring adorn the Boreal world. In concluding, Father du Tilly expressed the wish that more scientists may continue in the footsteps of those pioneers in the discovery of the treasures of the polar regions.

296TH MEETING

The 296th regular meeting was held in the assembly hall of the Cosmos Club, March 7, 1939, President Charles Thom presiding; attendance 90. Fred A. Abegg, Carl O. Grassl, R. A. Steingberg, and Josephine Ross were elected to membership.

Notes and reviews.—M. B. Waite showed some specimens of a rare moss, *Buxbaumia aphylla*, which he and A. V. Smith collected on his farm near the Patuxent River in Maryland.

Program—Dorothy Blaisdell: *Variability studies in the tomato* Fusarium *wilt organism; cultural studies.*—Thirty geographical strains of *Fusarium bulbigenum* var. *lycopersici* were collected from widely separate regions of the United States. These were grown on many different types of solid, liquid and tissue media to determine range of variability, and constancy of cultural characters. The largest number of isolates were divided into two main cultural types: the white, raised sclerotoid forms (RS), and the vinaceous purple, slimy, appressed form (A). Types intervening between these occurred: a group with dark undermats covered with coarse water-soaked mycelium of intermediate raised appearance (IR), and an intermediate appressed group with dark undermats having light fibrilous aerial growth (IA). A raised type was also found (R) similar to RS but without sclerotia and of more stable character. The raised and appressed strains could easily be distinguished on all types of media.

Sectors often appeared in the RS forms. Transfers from these yielded the appressed, slimy forms or intermediate types. Single sporing of the raised sclerotoid forms also yielded both appressed and raised types.

F. L. Wellman: *Variability studies in the tomato* Fusarium *wilt organism; pathogenicity studies* (lantern).—Studies of 30 tomato wilt *Fusarium* isolates obtained from diverse regions of the United States showed all, except one, to be *Fusarium bulbigenum* var. *lycopersici*. These cultures were readily separable on the basis of growth appearances into five types, which were found to be correlated with pathogenicity variations observed on tomato varieties susceptible, tolerant, and resistant to *Fusarium* wilt.

Cultures with raised (R) light-colored mycelium were most virulent; raised types with sclerotial-like bodies (RS) were erratic but next in pathogenicity; intermediate raised (IR) types were somewhat lower in pathogenicity; intermediate appressed (IA) were next to the least pathogenic type; and the dark colored completely appressed (A) cultures with no aerial mycelium were the least effective pathogenically. Data from infection studies on the three tomato varieties showed marked divergences in intensity of pathogenic effects due to differences in relative disease resistance.

C. O. Erlanson: *The first South American Meeting of Botanists, October 12–19, 1938.*

Ernst J. Schreiner: *Forest tree breeding* (lantern).

297TH MEETING

The annual banquet and 297th meeting of the Botanical Society was held in the Italian Garden of the Mayflower Hotel, April 4, 1939, attendance 125.

Program.—**Ira N. Gabrielson**: *Western American alpine plants* (lantern). —A discussion of personal experiences in seeking out and photographing alpine plants in many western mountain areas. The Olympics, Siskiyous, Cascades, Blue Mountains, and several desert ranges in southeastern Oregon were the principal areas visited. It is necessary to make many seasonal trips into each area in order to find the flowers at their best General floras at or near timberline are strikingly similar, but in many ranges distinct and often beautiful forms and species have been developed. The Siskiyous and Olympics are particularly rich in localized species.

298TH MEETING

The 298th regular meeting was held in the assembly hall of the Cosmos Club, May 2, 1939, President **Charles Thom** presiding; attendance 110.

Notes and reviews.—**John A Stevenson** called attention to his observation of squirrels cutting off elm leaves and twigs at the rate of 4 a minute. They were also cutting off seed pods.

M. B. Waite displayed a moss protonema that he had found growing in abundance on ground in which potatoes had grown. The ground had been bare in November and now was covered with this moss protonema.

Program.—**W. A. Archer**: *Indian medicinal plants in Nevada.*

H. L. Crane: *Tung-oil industry in the South.*

JOINT MEETING

A joint meeting of the Botanical Society and the Biological Society was held in the assembly hall of the Cosmos Club, April 14, 1939, President **Charles Thom** presiding; attendance 200.

Program.—**Lois Jotter**: *A botanical trip down the Colorado River by boat from Greenriver, Utah, through the Grand Canyon, to Boulder City, Nevada, August 1938.*

SPECIAL MEETING

A special meeting was held in the assembly hall of the Cosmos Club, September 26, 1939, President Charles Thom presiding; attendance 110.

Program.—A. H. Reginald Buller: *The sexual process in the rust fungi* (lantern and models).—In long-cycled heteroecious heterothallic rust fungi, *e.g.*, *Puccinia graminis*, the sexual process may be initiated in two different ways: (1) In compound pustules where a (+) mycelium derived from a (+) basidiospore has fused with a (−) mycelium derived from a (−) basidiospore, by an exchange of nuclei, (+) nuclei traveling through the (−) mycelium to the (−) proto-aecidia and (−) nuclei traveling through the (+) mycelium to the (+) proto-aecidia; and (2) where (+) and (−) pustules are widely separated from one another so that compound pustules cannot be formed, by insects conveying (+) pycnidiospores from (+) pustules to (−) pustules and (−) pycnidiospores from (−) pustules to (+) pustules, then by (+) pycnidiospores fusing with (−) flexuous hyphae and (−) pycnidiospores fusing with (+) flexuous hyphae and, finally, by the nuclei of the pycnidiospores traveling down flexuous hyphae to the proto-aecidia Flexuous hyphae are special hyphae projecting beyond the periphyses into the drop of nectar that is exuded from the ostiole of every active pycnidium.

299TH MEETING

The 299th regular meeting was held in the assembly hall of the Cosmos Club, October 3, 1939, President Charles Thom presiding; attendance 100. Olaf S. Aaomdt was elected to membership.

Notes and reviews.—M. B. Waite exhibited a moss, *Webera sessilis*, which he found growing near Patuxent, Md. It does not have any stem and is about one-fifth the size of a kernel of wheat and is commonly called "powder gun." He also displayed a plant, *Oldlandia uniflora*, which he found growing at the Horticultural Station at Beltsville, Md. It is related to the common spring bluet. He also called attention to a Bartram's oak (*Quercus heterofilia*), which is growing at Twelfth and C Streets, SW., Washington, D. C. J. B. S. Norton stated there was a Bartram's oak on the Boulevard near Riverdale, Md.

Program.—S. F. Blake: *Early American botanists, John Bannister (1650–1692), John Clayton (1686–1773), Humphrey Marshall (1722–1801).*—John Bannister, born in England, visited the West Indies and settled in Virginia in 1678. He collected plants and animals and published several papers on these subjects. His most important botanical work is his list of about 147 Virginia plants, published in Ray's *Historia plantarum* in 1698. John Clayton, born in England came to Virginia in 1705 and was assistant clerk and clerk of Gloster County for over 50 years. His extensive botanical collection from Tidewater Virginia were the foundation of Gronovius's *Flora Virginica* (1739–1743), the most important single basis for North American species in Linnaeus's *Species plantarum*. Humphrey Marshall, a cousin of John Bartram, was born and lived all his life in eastern Pennsylvania. He established a private botanical garden, and published his *Arbustrum Americanum* in 1785. This was the first work on United States botany published in the United States.

M. Thomas Bartram: *An early American botanist, John Bartram 1699–1777.*—John Bartram, grandson of a colonist under William Penn, can best be described as a plain farmer possessing only a country school education supplemented by wide reading in physics and medicine. His interest in botany was acquired while still in his twenties, and his knowledge of the subject was self-taught through extensive correspondence with American and European botanists, and the reading of the contributions of Linnaeus and others. His garden of native plants and shrubs, started in 1731 and in existence today, is recorded as the earliest in America and served as a source for the shipment of all types of botanical specimens to subscribers in Europe. The revenue derived from this activity supported extensive explorations from "New England to Florida; and from the sea coast to Lake Ontario and branches of the Ohio." In 1765 he was appointed "Botanist to the King" and commissioned to explore Florida and the St. John River.

Robert F. Martin: *An early American botanist, Thomas Walter 1740?–1789.*

300th MEETING

The 300th regular meeting preceded by an informal dinner at Hogate's Restaurant, was held at the restaurant, 8:30 P. M., November 7, 1939; attendance 150.

Notes and reviews.—M. B. Waite as master of ceremonies briefly reminisced about the early botanists of the society as their pictures were shown on the screen.

Program.—C Stuart Gager: *How botany advances* —This address stressed the importance for the advancement of botany, and of science in general, of strict adherence to the scientific method, and illustrated the errors and the absurdities into which students of plant life have been led by failure to employ what is now generally recognized as "the method of science." These illustrations were drawn from the writings of Aristotle (384–322 B. C.), Caesalpino (1583), Oken, the "physio-philosopher" (1809), Nicolaus of Cusa (1514), Van Helmont (1648), Gerard (1597), Parkinson (1640), and others.

In addition to the more commonly recognized steps of scientific method (observation, experiment, the formulation and testing of hypotheses), the the speaker emphasized the importance of another factor less often stressed, namely, what has been called the "divination" or "revelation" of the solution of scientific problems, which Lord Kelvin described as characterizing his own process. The contrast was also noted between Darwin's statement of his procedure, from facts to concept (natural selection), and de Vries's statement of his procedure, namely, from concept (intracellular pangenesis) to observation of facts and finally the formulation of the generalization of mutation. Alice M. Andersen, *Recording Secretary.*

Obituary

Thomas Allen Groover, physician and radiologist, died on April 20, 1940, from x-ray injuries dating from the early days of his investigations.

Dr. Groover was born at Pidcock in southern Georgia on May 1, 1877, a son of Thomas Alfred and Sarah Jane (Joiner) Groover. His father, a farmer, was a Confederate soldier during the Civil War and had lost an arm in action. Dr. Groover received his early education in the public schools of Brooks County, Ga. Because of financial considerations it did not seem possible for him to continue his education, but through the good offices of the Hon. Hoke Smith, of Georgia, Secretary of the Interior in President Cleveland's Cabinet, he was appointed assistant messenger in the Department of the Interior. He came to Washington in 1893 and resided here the remainder of his life. In 1894 he entered the Medical Department of Columbian University, later George Washington University, and graduated in

1898. In 1926 his alma mater conferred upon him the degree of doctor of science. After internship at the Garfield Memorial Hospital he was appointed physician with the Isthmian Canal Commission and in that capacity spent the next year in Nicaragua.

He returned to Washington in 1900 and entered the general practice of medicine. At the same time he began x-ray work at the Central Dispensary and Emergency Hospital. Although he did not completely specialize in radiology until 1912, he was actively engaged in that field from 1900 up to within three months of his death. It was in those early days from 1900 to about 1904 or 1905 that he suffered the injuries to his hands that resulted in amputation through the left forearm in 1926 and to final involvement of the right axilla and lung, which cost him his life.

Dr. Groover was closely associated with the scientific progress and the organizational development of radiology in this country. He made numerous contributions to the literature and was always interested and quietly helpful in everything that affected the welfare of the specialty he loved. He was insistent, however, that the radiologist is primarily a physician, and as such he always established a personal relationship with every patient who came under his care.

Dr. Groover's work as a practicing radiologist was characterized by the utmost painstaking care and attention to detail. He not only required the best possible technical work but spared no time or personal effort to arrive at a correct interpretation and final diagnosis. He had developed in himself to a very high degree those qualities that are indispensable in the good physician, accuracy in observation and a keen sense of relative values. He was a diagnostician of unusual ability. In manner Dr. Groover was quiet and reserved. Being of a very studious habit, he made it a rule to spend at least one hour a day in reading medical literature. He had great qualities both of mind and heart that were unusual and outstanding. His ability as an organizer and executive was recognized. His careful, methodical attention to all the details of bookkeeping, records, and management laid the foundation for his professional work. He always looked upon business arrangements, however, as a means to more important ends. He was first and last a physician. Even radiology, in every branch of which he was proficient, he insisted must always be looked upon as an integral part of general medical practice. His outstanding mental characteristics were patience and a great capacity for methodical, painstaking care in every diagnostic and therapeutic procedure. His dominant moral characteristic was a keen sense of justice, right, and fair dealing. He had an unfailing patience in compromising differences of opinion among his associates, a sane judgment in arriving at important decisions, and above all, a kindly, tolerant charity toward all with whom he could not agree. He will be greatly missed by his close associates who were accustomed to call upon him almost daily for his helpful counsel, and his loss will be keenly felt in many organizations in which his advice was highly valued. His death adds another martyr to the long roll of those who have sacrificed their lives in the interests of science and humanity.

Dr. Groover was a member of the following organizations: The Washington Academy of Sciences (vice-president, 1925); the Medical Society of the District of Columbia (president, 1925); the American Medical Association (fellow); the American College of Physicians (fellow); the Southern Medical Association (vice-president, 1924); the American Roentgen Ray Society (president, 1925); the Radiological Society of North America; and the American College of Radiology (fellow), in which he served both as president and as chancellor.

JOURNAL
OF THE
WASHINGTON ACADEMY OF SCIENCES

VOL. 30 NOVEMBER 15, 1940 No. 11

BIOCHEMISTRY.—*The bacteriostatic and the bactericidal action of certain organic sulphur compounds.*[1]

EDWARD L. EVERITT and M. X. SULLIVAN, Georgetown University.

For a number of years in the field of chemotherapy investigations have been carried on relative to the treatment of various infections of man by certain chemicals. The importance of the use of chemical substances lies in the possibility of checking or destroying the invading organisms, or in offsetting the products of the activity of the organisms in question. Since many compounds having fungicidal or bactericidal properties are harmful to the body tissues, very few chemical compounds have been found useful for internal application, such as injection into muscles or directly into the blood stream.

Within the past few years, however, several compounds have been discovered that are of value in the treatment of pneumonia and of certain streptococcic infections. Thus, Rosenthal (1934) investigated the action of sodium formaldehyde sulphoxylate on virulent pneumococci and found it effective against one strain of the organism among the 32 strains studied with mice. The sulphoxylate, as the complex is called, was injected into mice inoculated with the particular strain of pneumococci under investigation. In contrast to its effectiveness in mice was the fact that in vitro tests showed that the compound had little if any bactericidal or bacteriostatic action. Domagk (1935) in Germany then announced a discovery that has revived chemotherapeutic research. He found that the addition of a sulphamide group into certain azo dyes would protect or cure mice infected with fatal doses of hemolytic streptococci and that this effect was not correlated with in vitro experiments, in which the compounds had little effect on the organisms.

The compounds found most effective by Domagk were: 4-sulphonamide-2, 4-diamino-azobenzene, and 4-sulphonamide-phenyl-2-azo-7-acetylamino-1-hydroxynaphthalene-3, 6-sodium disulphonate, which

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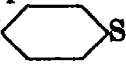
[1] The data in this paper are taken in part from the dissertation presented by Edward L. Everitt in partial fulfillment of the requirements for the degree of doctor of philosophy, Georgetown University, 1937. Received July 9, 1940.

were named respectively prontosil and prontosil soluble. Domagk's work was soon followed by that of Trefouel, Nitti, and Bovet (1935), who described a sulphonamide product that did not contain the azo-group but that still had chemotherapeutic activity. This compound, p-aminobenzene sulphonamide, H_2NSO_2NH_2, was first known as prontylin and has been extensively used in this country and abroad under the name sulphanilamide. It has been found very valuable therapeutically against several infectious diseases, streptococci infections in particular. An excellent review with 162 references has been made by Holman and Duff (1938).

In work with various sulphur compounds, started long before the publication of Domagk's work and subsequent work of others on sulphanilamide and its main derivatives, we found that a number of organic sulphur compounds investigated in vitro had a fungistatic or a fungicidal action on various molds (Everitt and Sullivan, 1940). The compounds made use of in the mold studies were then tested as to their bacteriostatic and bactericidal actions, with especial attention to the streptococci and staphylococci.

The culture media employed in the study of the growth of the bacteria were those commonly used in bacteriological work and were made up as follows, (A) and (B):

(A) BROTH MEDIUM

Neopeptone	10 grams
Sodium chloride	5 grams
Water to make	1,000 cc

This culture medium was adjusted to pH 7.6, and 50-cc portions were placed in 125-cc Erlenmeyer flasks. The sulphur compounds were added in specified amounts, and the flasks were plugged with cotton and sterilized at 15 pounds pressure for 30 minutes. Certain flasks without the particular compounds served as controls.

(B) BLOOD AGAR SLANTS

The viability of the microorganisms on medium (A) with and without the added sulphur compounds was further determined by making transfers to blood agar slants. These slants were made by adding 0.5 cc of sterile blood to tubes of agar made up as follows:

Beef extract	3 grams
Peptone	10 grams
Sodium chloride	5 grams
Agar-agar	15–18 grams
Water to make	1,000 cc

The agar solution was then tubed, plugged with cotton, and sterilized at 15 pounds pressure for 30 minutes. The sterile blood was added by means of sterile pipettes to these sterilized tubes of agar after they had been cooled in a slanting position.

In the study, the bacterial culture medium (broth medium) was inoculated by the addition to the various flasks of two drops of an 18- to 24-hour peptone medium growth of the particular organism.

The inoculation of the blood agar slants was made by transferring a 6-mm loopful of the culture media to the surface of the slants.

In each case, whether in broth or agar slants, the bacterial cultures were incubated at 37° C.

A series of preliminary tests with a number of sulphur compounds to determine their bacteriostatic and bactericidal properties was undertaken with the use of *Staphylococcus aureus* as the test organism. As this organism was found very resistant, its study was deferred until other possibly more potent compounds could be made, and attention was paid to the streptococci, considered of more importance from the standpoint of human infections. The streptococci employed were (a) *Streptococcus hemolyticus* (oyler strain) isolated from a patient with an infection on the dorsal surface of the hand and found capable of producing beta hemolysis; (b) *Streptococcus hemolyticus epidemicus* Group A, obtained from Dr. Alice Evans, National Institute of Health. It belonged to Lancefield's group A and was virulent to white mice; (c) *Streptococcus viridans* No. 2, obtained from Dr. Cecil in 1935. It produced alpha hemolysis. All the streptococci used were provided by the Department of Bacteriology, Georgetown University Medical School.

In preliminary work about 50 chemicals previously tested in mold growth and listed in the reference to the fungicidal and fungistatic action of various sulphur compounds by Everitt and Sullivan (1940) were tested for their effect on the streptococci. Only a few seemed promising from a bacteriostatic or bactericidal standpoint. These possibly useful compounds are as follows:

(3) Phenothioxine
(10) Phenyl thioarsenite
(11) 4-chloro-2-nitrophenyl sulphur amine
(14) Thioacetamide
(15) Mercaptobenzothiazole
(16) Phenylbenzothiazole
(17) Sodium diethyldithiocarbamate
(18) Diethylthiourea

(31) Thiobarbituric acid
(32) Benzyl disulphide
(33) Colloidal sulphur (sulphur diasporal)
(34) Colloidal sulphur (sulisocol)
(36) 1,2 naphthoquinone-4-sodium sulphonate

The effect of the various compounds was determined by incubating the broth culture containing the test material for 24 to 96 hours and at each twenty-fourth hour transferring a loopful to blood agar slants for a further judgment as to growth. The effect of the compounds on the bacteria is given in Tables 1, 2, and 3.

TABLE 1.—STUDY OF THE MOST PROMISING SULPHUR COMPOUNDS FOR ACTION ON STREPTOCOCCUS HEMOLYTICUS (OYLER STRAIN)

Sulphur compound No.	Amount used in 100 cc	Time interval of incubation in hours on medium (A) before transplanting to blood agar[1]			
		24	48	72	96
	mg				
Control..	—	+	+	+	
(3)	20	+	0	0	0
	15	+	+	1 colony	0
(14)	15	15 colonies	+	+	0
(15)	10	0	0	0	0
(16)	10	0	+	+	+
(17).	15	0	0	0	0
(18) .	15	+	0	0	0
(31)	15	1 colony	+	0	0
(32).	20	0	0	0	0
(33)	20	0	0	+	+
(34)	20	+	0	0	0
(36) ..	15	0	0	0	0

[1] The sign (+) signifies growth on the blood agar, (0) no growth.

TABLE 2.—STUDY OF SULPHUR COMPOUNDS ON GROWTH OF STREPTOCOCCUS HEMOLYTICUS EPIDEMICUS

Sulphur compound No.	Amount used in 100 cc	Time interval of incubation in hours on medium (A) before transfer to blood agar[1]				
		24	48	72	96	120
	mg					
Control.	—	+	+	+	+	0
(3). .	10	0	0	0	0	0
(10). .	10	0	0	0	0	0
(11) .	15	1 colony	0	0	0	0
(14).	10	0	0	0	0	0
(15). . .	10	0	0	0	0	0
(16). . . .	10	+	0	+	0	0
(18). . .	15	6 colonies	0	0	0	0
(31). .	15	+	+	+	+	
(32). . .	15	+	+	+	+	
(33). .	20	0	0	0	0	
(34). . . .	20	0	0	0	0	
(36). .	10	+	0	0	0	0
	5	+	0	0	0	0

[1] The sign (+) signifies growth on the blood agar, (0) no growth.

TABLE 3.—ACTION OF CERTAIN OF THE SULPHUR COMPOUNDS ON STREPTOCOCCUS VIRIDANS INCUBATED IN 24-HOUR PERIODS ON MEDIUM (A) AND A LOOPFUL OF BROTH TRANSFERRED TO BLOOD AGAR SLANTS TO DETERMINE GROWTH

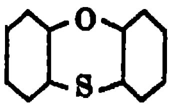
Sulphur compound No.	Amount used in 50 cc	Time in hours				
		24	48	72	96	120
	mg					
(3)	5 0	+	+	+	+	+
	7 5	+	+	0	0	0
(15)	5 0	15 colonies	+	+	+	0
(16)	5 0	+	+	+	+	+
(17)	7 5	+	+	+	+	3 colonies
(18)	7 5	+	+	+	+	+
(10)	5 0	1 colony	+	2 colonies	+	0
(11)	7 5	+	+	+	+	+

A study of Table 1 will show that a number of compounds have a retarding action in vitro on the growth of *Streptococcus hemolyticus* (oyler strain). These compounds are 3, 15, 17, 18, 32, 33, 34, and 36, and of these 15, 17, and 36 were the most effective. Similarly, as shown in Table 2, a number of compounds inhibited the growth of *Streptococcus hemolyticus epidemicus*. These compounds are 3, 10, 11, 14, 15, 16, 18, 33, 34, and 36.

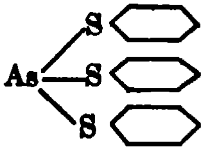
Of the compounds tested and found inhibiting on both strains of streptococci there may be listed nos. 3, 15, 18, 33, 34, and 36. Compounds 33 and 34, colloidal sulphur preparations, may be effective because they are alkaline in reaction and may change the hydrogen-ion concentration of the culture medium sufficiently to inhibit the growth of the organisms. Since this question called for a detailed study, these compounds were set aside for further consideration. Since compound 36 (1, 2 naphthoquinone-4-sodium sulphonate) was early shown by Herter (1905) to have more or less toxicity toward animals, the use in offsetting the action of streptococci in vivo might be questionable.

Finding that various compounds checked the growth of *Streptococcus hemolyticus* and *Streptococcus hemolyticus epidemicus*, we decided to study their effect on the highly virulent microorganism *Streptococcus viridans*, the checking of which has long been a desired need in medical practice. The results with *Streptococcus viridans* are shown in Table 3.

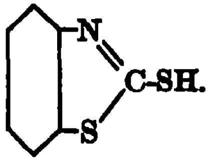
It is obvious from Table 3 that *Streptococcus viridans* is more resistant to the action of the various compounds than are *Streptococcus hemolyticus* and *Streptococcus hemolyticus epidemicus*. *Streptococcus viridans* infection in human beings usually has a very unfavorable outcome and is one of the organisms for which some effective compound should be found. Of the compounds tested, only three seem to have some inhibiting action on *Streptococcus viridans*. These compounds are nos. 3, phenothioxine,



10, phenyl thioarsenite,



and 15, mercaptobenzothiazole,



Of these compounds, mercaptobenzothiazole was on hand in plentiful supply, and some attention was paid to it from a chemical and a clinical viewpoint. As may be seen from its formula, it is an organic sulphur compound containing nitrogen and in addition a -SH group. This compound, which was first made by Hofmann (1887), has been used for a number of years in the rubber industry as an accelerator of vulcanization. Its use for this purpose seems to have been first suggested by Bedford and Sebrell (1921). It may be purchased from the Eastman Kodak Co. It is moderately soluble in alcohol, ether, chloroform, and benzol, alkalies, and alkali carbonate solutions but not very soluble in water.

Roark and Busbey (1935) state that mercaptobenzothiazole in concentrations of 0.01 to 0.10 percent was effective in controlling a fungus living on wood and that it has been used in controlling aphids and mosquito larvae. Davis (1930) reported on the toxicity of the compound. He injected an aqueous solution of it into guinea pigs and a total injection of 14.5 mg in 20 days did not produce any injurious effects on the animals. Also, medical examinations of the men working with mercaptobenzothiazole over a period of years in the Goodyear Tire & Rubber Co. did not show any toxic condition or dermatoses. We have given 20–100 mg of the compound by mouth to guinea pigs weighing 400 grams with no gross evidence of toxicity. The disadvantages of using mercaptobenzothiazole are its slight solubility and its tendency to chemical change when in an alkaline solution.

In preliminary work, phenothioxine in a slightly alkaline medium and at a level of 20 mg per 100 cc has shown good bacteriostatic action on the streptococci, even on *Streptococcus viridans*. Phenothioxine however, is rather difficultly soluble in the culture media, but it can be converted readily to a more soluble sulphonate which will be investigated further in vitro and in vivo.

SUMMARY

In testing about 50 organic sulphur compounds as regards their effect on the growth of various streptococci, a number of compounds were found to have more or less bacteriostatic or bactericidal power at a level of 100 parts per million of peptone broth. The most promising compounds are phenothioxine, which showed marked bacteriostatic action on *Streptococcus hemolyticus* (oyler strain) and *Streptococcus hemolyticus epidemicus* and considerable inhibition of *Streptococcus viridans;* and mercaptobenzothiazole, which showed bactericidal action on *Streptococcus hemolyticus* (oyler strain) and on *Streptococcus hemolyticus epidemicus*, but not on *Streptococcus viridans*. The criterion of biological action of the various compounds was the degree of growth on blood agar slants after a period in peptone broth culture with and without the compound under study.

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PALEOBOTANY.—A Cusparia *from the Pliocene of trans-Andean Bolivia.*[1] EDWARD W. BERRY, Johns Hopkins University.

The specimens on which the following note is based were collected many years ago by Dr. Edwin Kirk, to whom I am indebted for them as well as the information regarding their geological setting.

They were collected at Agua Salada (lat. 21° 50′ 20″ S., long. 63° 30′ W.), which is about 25 kilometers northeast of Yacuiba, Bolivia, from the surface of an argillaceous deposit, some thousands of feet above the base of what Bonarelli[2] called the "Terciario subandino." This is more or less the equivalent of what Madgwick called the Upper Sacarigua beds; Heald and Mather the San Ysidro formation; and Mather the Tatarenda formation. Similar deposits in this general region were earlier christened the Jujuy formation by Steinmann. Beds of this character extend in the sub-Andean zone through many degrees of latitude and appear to be lithologically and genetically similar. They appear to be poorly fossiliferous everywhere, although doubtless detailed searching of outcrops in this superficially explored region might greatly modify this statement. Bonarelli and others have reported obscure molluscan remains and ostracods; Harrington collected insects, which were described by Cockerell(1925); Kraglievic records a sloth cranium (*Scelidodon*); and Kirk collected a mammalian jaw which Gidley regarded as of Pliocene age. Fossil leaves of *Cassia chrysocarpoides* Engelhardt were collected at Carandaiti,[3] which is about 150 miles north of Agua Salada.

This last is a common Potosi form and a *Corbicula* mentioned by Bonarelli also occurs in the inter-Andean Pliocene.

In previous discussions of the date of the final uplift of the Andes mention has been made of the thick series of erosion products that accompanied this uplift, remnants of which skirt the mountains from eastern Colombia southward to western Argentina and from which a considerable number of fossil plants have been described, as at the Rio Aguaytia locality in eastern Peru, or molluscan faunas as near Pebas, Peru. Some of the latter as well as many of the plants are identical with inter-Andean forms from the Cuenca and Loja basins in Ecuador, from the headwaters of the Orinoco system in Colombia, or the headwaters of the Amazon system in eastern Ecuador and Peru, the Territory of Acre in western Brasil, and in eastern Bolivia.

It appears to me that they all clearly represent a part of the same

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[1] Received July 25, 1940.

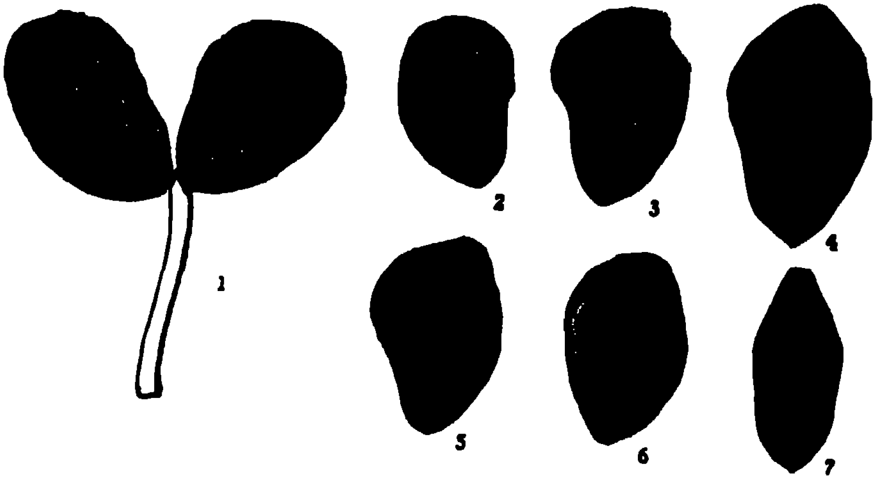
[2] BONARELLI, G. Anal. Min. Agr. 15: (1). 1921.

[3] BERRY, E. W. Johns Hopkins Univ. Stud. Geol. No. 13: 51. 1939.

geological epsiode and are of about the same age, although it obviously would be inaccurate to assume exact correlation of named lithologic units through this vast distance, especially with the realization of the difficulty of the country and the reconnaissance nature of its exploration. The fossil fruits from Agua Salada are tentatively identified as belonging to the rutaceous genus *Cusparia* and may be described as follows:

Cusparia yacuibana Berry, n. sp. Figs. 1–7

Carpels unsymmetrically egg-shaped ranging from irregularly obovate to subrhomboidal in lateral profile, somewhat compressed, rounded above and obtusely pointed proximad, a slight sinus on the ventral border. Substance crustaceous or bony. Surface with a characteristic sculpture, heavily rugose. Ribs comprising a broad, rounded, lunate rib originating near the middle of the ventral margin curving outward and downward subparallel with the dorsal margin. This central rib divides the surface into two regions—above it there are at least two major and one or two minor ribs, all subparallel; below it there are three or four similar ribs more parallel with the axis of the fruit and gradually becoming obsolete at its base. All the ribs are subject to considerable variation in both extent and magnitude. Dimensions: Length, ranging from 7 to 10; maximum width, 5 to 7; thickness, 4 to 5 mm.



Figs 1–7.—*Cusparia yacuibana* Berry: 1, Two specimens assembled to depict a fruit consisting of two capsules; 2–4, lateral views of valves; 5, 6, internal views of valves showing outline of the single seed, placenta, and dorsal dehiscence canal; 7, ventral view of partly opened capsule. All ×2

Carpel is tardily dehiscent into two equal valves, well shown in Figs. 1–4. At least one specimen preserves the single reniform seed, which is hard and smooth and exactly fills the cavity. By voluntary shifting the focus of the eyes the observer of Figs. 5 and 6 can get the exact picture of the valve with the seed preserved except that the seed is smooth and rounded dorsally and does not extend into the canal through the upper dorsal wall of the capsule. This canal has been puzzling. It can not be detected in all the specimens, nor is any trace of it shown from the outside in the unopened specimens. It is present in the majority of dehisced valves and appears to make the dorsal limit of dehiscence. The wall must have differed naturally in structure along this line although nothing can be made out microscopically. In Fig. 3 a considerable sinus on the upper dorsal margin is shown at this point.

The seed is interpreted as pointed at the base, although no trace of a stylar canal is preserved in the capsule wall. The hilum is supposed to be at the concavity on the ventral side, and the swollen wall around which it fits is supposed to represent the placenta. No trace of a funicular canal can be detected in any of the specimens.

These carpels, seemingly so individualistic and well marked, have baffled both identification and interpretation for many years. I have submitted them to systematists at some of our larger herbaria as well as to experts in the study of fossil carpology, such as Mrs. Reed, the well-known British authority, to all of whom I am grateful. One insuperable difficulty as usual is to find comparable recent material since most botanical species are founded on herbarium material of flowers and leaves.

For a long time I was convinced that the specimens represented the stones of a drupe or berry. Arguments for such an interpretation are the traces of a dark organic substance in the grooves between the ribs; the stony character; the lack of traces of attachment; the fact that 10 specimens were unopened and there were but 28 half specimens. Arguments for a capsular nature was the dehiscence of a majority of the specimens; the prevalence of the capsule habit in this region of the Rutaceae and the somewhat similar ornamentation in many of the Recent genera some of which have bony capsules. The consensus of the authorities consulted was that the fossils were closely related to the genus *Cusparia*, and since I can not believe that an extinct genus was in existence as late as the Pliocene in tropical South America, I have ventured to describe them as an extinct species of that genus, and I am optimistic enough to expect that when the botanical exploration of that vast region shall be more complete than it now is this extinct species may be found to be a still existing one. Decision as to habit and orientation has also been difficult. At first I assumed that the more pointed end to which the ribs converged was the apex, but a review of the literature and such recent material as was available convinces me that the widest part of the capsule is distad and the narrower end from which the ribs diverge is the proximal part. All the material that I have seen has the ornamentation disposed in this pattern.

There are many similar, but not identical, Recent forms in the Cusparieae especially in the genera *Cusparia*, *Pilocarpus*, and *Raputia*. In *Cusparia*, to which the fossils conform more closely than to the others, the mature capsules are one to three and rarely four in number. I am giving a restoration of the fossil in which two capsules are shown as having matured.

The subfamily Cusparieae comprises 16 genera with upward of 100 known species, all American, in the existing flora. Engler, who prepared the account of the Rutaceae in Martius's *Flora Brasiliensis* and for *Das natürlichen Pflanzenfamilien*, discussed the geographical distribution in a special paper[4] in 1816, since when there has been considerable botanical exploration, and it now seems probable that most of the genera of the Cusparieae, certainly all the larger genera, may be expected to be found anywhere in the neotropical region of South America centering in the Orinoco and Amazon basins, extending to the Greater Antilles (Cuba, Haiti, and Puerto Rico) in the genus *Ravenia*, to Central America and southern Mexico in the genus *Erythrochiton*, to Paraguay and Uruguay in the genus *Pilocarpus*, and to the eastern Andean slopes of Peru and Bolivia in the genera *Erythrochiton* and *Cusparia*, and probably in the majority of other genera of this subfamily.

At least two species of *Cusparia* (*ramiflora* and *toxicaria*) are recorded from the upper Amazonian drainage basin, and one (*pilocarpoidea*), although with capsules not close to the fossil, is found in eastern Bolivia.

Cusparia, so far as I know, has not previously been found fossil, and the same statement is true of 12 of the other genera comprising this subfamily. The three genera, in addition to the present occurrence of *Cusparia*, which have furnished fossils are (1) *Pilocarpus*, species of which are recorded from the lower Miocene of Coronel, Chile, the Pliocene of Psillypampa, Bolivia, and the Pliocene of Aramary and Marahii in eastern Brazil; (2) *Ticorea*, which is recorded from the lower Miocene of Chile; and (3) *Erythrochiton* with a species associated with *Ticorea* and a second from the Pliocene of eastern Brazil (Aramary in the State of Bahia and Fonseca in the State of Minas Geraes).

BOTANY.—*New species and new names among Arizona Asteraceae.*[1]

S. F. Blake, U. S. Bureau of Plant Industry.

The following new species, new varieties, and new combinations are published here in order that they may be available for the *Flowering plants and ferns of Arizona*, by T. H. Kearney and R. H. Peebles, now in course of publication by the U. S. Department of Agriculture.

Kuhnia rosmarinifolia Vent. var. **chlorolepis** (Woot. and Standl.) Blake

Kuhnia chlorolepis Woot. and Standl. Contr. U. S. Nat. Herb. 16: 177. 1913.

Aplopappus croceus Gray var. **genuflexus** (Greene) Blake

Pyrrocoma genuflexa Greene, Pittonia 3: 348. 1898.
Haplopappus croceus subsp. *genuflexus* Hall, Genus Haplopappus 99. 1928.

Chrysothamnus pulchellus (Gray) Greene var. **baileyi**
(Woot. and Standl.) Blake

Chrysothamnus baileyi Woot. and Standl. Contr. U. S. Nat. Herb. 16: 181. 1923.
Chrysothamnus pulchellus subsp. *baileyi* Hall and Clements, Phylogen. Meth. Taxon. 194. 1923.

[4] Engler, A. *Über die geographische Verbreitung der Rutaceae im Verhältnis zu ihrer systematischen Gliederung.* Abh. Preuss. Akad. Wiss. 1896: 1–27, pls. 1–3. 1896.

[1] Received October 8, 1940.

Chrysothamnus viscidiflorus (Hook.) Nutt. var. **elegans** (Greene) Blake

Chrysothamnus elegans Greene, Erythea 3: 94. 1895.
Chrysothamnus viscidiflorus subsp. *elegans* Hall and Clements, Phylogen. Meth. Taxon. 183. 1923.

Chrysothamnus viscidiflorus var. **molestus** Blake, var. nov.

Suffrutex 8–12 cm altus pluricaulis; caules albo-corticati foliosi normaliter infra inflorescentiam simplices ut folia subdense hirtelli pilis brevibus patentibus albis conicis saepe glanduloso-capitatis; folia linearia vel infima anguste lineari-spathulata calloso-apiculata sessilia plana v. concava 1-nervia pallide viridia 7–15 mm longa 0.8–1.5 mm lata; cymae terminales folia superantia pauci- v. multicapitatae 1.5–4 cm latae ut caules hirtellae; capitula anguste cylindrica 5-flora fructu 1.2–1.5 cm alta (pappo incluso); involucri valde gradati 4-seriati 9.5–11 mm alti phyllaria in ordinibus 5 perpendiculatis ordinata linearia v. extima lineari-oblonga obtusa v. acutiuscula non valde carinata 0.8–1.2 mm lata dorso glabra vel extima parce hirtella substraminea scarioso-marginata margine prope apicem eroso-ciliata exteriora apice viridia; flores maturi involucro multo longiores; corollae tenues prope basin faucis parce puberulae ut videtur pallide flavae (6.3) 7.3–8.2 mm longae (tubo 1.8–2.3 mm, fauce 4.5–4.7 mm, dentibus 1–1.5 mm longis); achenia linearia 4.2–6 mm longa 6–8-nervia infra glabra supra dense glandulosa glandulis brevissime stipitatis; pappus vix copiosus stramineus corollam maturam aequans 8–9 mm longus, setis subequalibus hispidulis prope apicem longius hispidulis; antherarum appendices anguste lanceolatae 0.5–0.8 mm longae; styli rami 3–4 mm longi, lineis stigmaticis 1.3–3 mm appendicibus anguste subulatis hispidulis (1) 1.3–1.7 mm longis.

ARIZONA: On limestone slope in edge of piñon belt, easterly base of San Francisco Mountain, 45 miles from Flagstaff, Sept. 26, 1920, *H. M. Hall* 11184 (Herb. Univ. Calif. no. 205824); between Williams and Grand Canyon, west of San Francisco Mountain, on plains, Sept. 27, 1920, *Hall* 11199 (type no. 1288511, U. S. Nat. Herb.; duplicate, Herb. Univ. Calif. no. 205819); open rocky park, Tusayan Forest, T. 23 N., R. 3 E., altitude 2,135 m, Sept. 9, 1912, *A. D. Read* 165 (U. S. For. Serv. Herb. 5439).

This little shrub, known from three collections from the general region of San Francisco Peak in northern Arizona (Coconino County), is of considerable interest. Hall's specimens were identified by him as *Chrysothamnus depressus* Nutt., and the measurements of floral details (not made by Hall himself, and in part not agreeing with my own measurements from the same specimens) attached to the sheets in the University of California Herbarium are given in his table of measurements of that species The sheet in the U. S. Forest Service was originally identified by Dr. E. L. Greene as *C. pulchellus* (Gray) Greene, and later by the writer as *C. vaseyi* (Gray) Greene. It is rather surprising that the specimens should have been identified as *C. depressus* and *C. pulchellus*, since they completely lack the outstanding characteristic of these two species, namely strongly acuminate or cuspidate and strongly keeled phyllaries arranged in five very distinct vertical ranks. Their separation from *C. vaseyi*, with which as well as the two species just named they share the character of a merely glandular achene (not densely pubescent, as in the forms of *C. viscidiflorus* hitherto known), is much less readily made. *Chrysothamnus vaseyi*, which is not known from Arizona, is closely similar in habit to the new plant; its branches, although described by Gray, Rydberg, and Hall and Clements as glabrous, are often puberulous, but much less coarsely so than in the new plant, and never with glandular-capitate hairs developed; its leaves (sometimes finely puberulous) are normally longer and wider, with a weaker costa, usually indicated on the upper leaf surface, where the midrib in the new form is most prominently developed, only by an impressed line; its involucre is shorter (5.5–7 mm high), of broader and blunter phyllaries with less evident keel; its corollas are shorter (5.5–6.5 mm long), with relatively longer teeth (1.5–2 mm long); and its achenes are 9–10-nerved.

In achenial characters var. *molestus* is more like *C. vaseyi*, in which the achene is 9–10-ribbed, glabrous or glandular or rarely sparsely pubescent above, than the forms of *C. viscidiflorus*, in which the achene is about 5-nerved and almost always more or less densely pubescent but not glandular. The only previous record of the occurrence of nearly glabrous achenes among the forms of *C. viscidiflorus* seems to be in *C. marianus* Rydb., synonymized by Hall and Clements with *C. viscidiflorus* subsp *puberulus*, apparently correctly. In this the achenes were originally described as only slightly strigose, and in the type specimen (*Rydberg & Carleton* 6993) are said by Hall and Clements to be sparsely strigose or nearly glabrous.

The degree of variation in the proportions of the parts of the style in var. *molestus* is considerable and suggests that the emphasis placed on this feature by Hall and Clements in their monograph of *Chrysothamnus* may have been exaggerated. In the three collections now at hand, coming from a restricted region and extremely similar in all other characters, the style branches in normally developed flowers vary from 3 to 4 mm in length, the stigmatic lines from 1.3 to 3 mm, and the appendages from 1 to 1.7 mm, the appendages being sometimes distinctly longer than the stigmatic lines, sometimes slightly less than half as long.

Var. *molestus* is distinguished from all the forms of *C. viscidiflorus* hitherto known by its coarser pubescence consisting in part of gland-tipped hairs, its longer involucre, and its glandular achenes. In many of its characters it is more or less intermediate between *C. depressus* and *C. viscidiflorus* var. *elegans*, and might almost as well be considered a variant of *C. depressus* with blunt phyllaries. The varietal name refers to the difficulties its recognition introduces into the preparation of a key to the species of the genus. Hall states that the specimens collected under his no. 11184 were much browsed back by grazing animals.

Chrysothamnus greenei (Gray) Greene var. **filifolius** (Rydb.) Blake

Chrysothamnus filifolius Rydb. Bull. Torrey Club 28: 503. 1901.
Chrysothamnus greenei subsp. *filifolius* Hall and Clements, Phylogen. Meth. Taxon. 191. 1923.

Chrysothamnus nauseosus (Pall.) Britton var. **turbinatus** (Jones) Blake

Bigelovia turbinata Jones, Proc. Calif. Acad. II. 5: 691. 1895.
Chrysothamnus turbinatus Rydb. Fl. Rocky Mts. 859. 1917.
Chrysothamnus nauseosus subsp. *turbinatus* Hall and Clements, Phylogen. Meth. Taxon. 217. 1923.

Achaetogeron chihuahuensis Larsen, sp. nov.[3]

Herba annua (?) 10–30 cm alta pluricaulis; caules simplices v. parum ramosi adscendentes v. decumbentes 1–2-capitati saepe purpurascentes foliosi subdense pilosi v. hirsuti pilis infra patentibus supra adscendentibus v. subappressis; folia infima anguste spathulata v. oblanceolata longe petiolata utrinque pilosa v. hirsuta integra v. utroque latere 1-dentata obtusa v. acutiuscula 2–4 cm longa (petiolo incluso) 3–4 mm lata, caulina anguste oblanceolata v. linearia sessilia v. inferiora petiolata sursum sensim reducta; pedunculus 1.5–6 cm longus nudus v. subnudus adscendenti- v. subappresso-pilosus; capitula solitaria 1.5–2 cm lata; involucri 2-seriati subaequalis 4 mm alti phyllaria lanceolata acuminata patenti-pilosa et minute glandulari-puberula; radii numerosi pauciseriati sicco albidi v. lavandulaceo-tincti; achenia paullum compressa oblonga 2-nervia albida minute hirsutula 0.8 mm longa; pappus minimus coroniformis multisetulosus basi concretus 0.1 mm longus.

ARIZONA: White Mountain Apache Reservation, Apache County, June 25, 1907, *Mrs. Zuck;* semiwaste places, Thompson's Ranch, Black River, White Mountains, July 12, 1910, *L. N Goodding* 539.

CHIHUAHUA: Vicinity of Madera, alt. 2,250 m, May 27–June 3, 1908, *E. Palmer* 301 (type in Mo. Bot. Gard ; dupl. in U. S. Nat. Herb.), 302438; Colonia Garcia, in Sierra Madre, alt. 2,218 m, June 12, 1899, *Townsend & Barber* 32.

Of interest as the first species of this Mexican genus to be reported from the United States. In general appearance it resembles species of *Erigeron* such as *E. divergens* Torr. and Gray, but it is readily distinguished by the minute coroniform pappus. All the specimens cited are in the U. S. National Herbarium except *Townsend & Barber* 32, which may be present there but has not been located.

Aster commutatus (Torr. and Gray) Gray var. **crassulus** (Rydb.) Blake

Aster crassulus Rydb. Bull. Torrey Club 28: 504. 1901.
Aster commutatus crassulus Blake in Tidestrom, Contr. U. S. Nat. Herb. 25: 560. 1925.

Aster commutatus var. **polycephalus** (Rydb.) Blake

Aster scoparius DC. Prodr. 5: 242. 1836. Not *A. scoparius* Nees, 1818.
Aster polycephalus Rydb. Bull. Torrey Club 33: 153. 1906.
Aster commutatus polycephalus Blake in Tidestrom, Contr. U. S. Nat. Herb. 25: 560. 1925.

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[3] Description contributed from her unpublished revision of this genus by Esther L. Larsen, now Mrs. Kenneth D. Doak.

Aster arenosus (Heller) Blake

Aster ericaefolius var. *tenuis* Gray, Syn. Fl. 1²: 198. 1884.
Leucelene arenosa Heller, Cat. N. Amer. Pl. ed. 1. 8. 1898.

Aster adenolepis Blake, nom. nov.

Machaeranthera mucronata Greene, Pittonia 4: 72. 1899. Not *Aster mucronatus* Sheldon, 1903.

Aster aquifolius (Greene) Blake

Machaeranthera aquifolia Greene ex Woot. and Standl. Contr. U. S. Nat. Herb. 16: 188. 1913.

Erigeron perglaber Blake, sp. nov.

Perennis ut videtur suffrutescens 20 cm altus pluricaulis sparse et obscure stipitato-glandulosus primo visu glaberrimus; caules erecti tenues simplices v. ramo unico erecto donati infra foliosi superne nudi; folia anguste spathulata longe petiolata integerrima obtusa v. acutiuscula coriacea pallide viridia 1-nervia; capitula solitaria longiuscule pedunculata ca. 2 cm lata radiata; involucre ca. 3-seriati paullum gradati 5 mm alti phyllaria anguste linearia acuminata 0 3–0.5 mm lata appressa subchartacea costa glandulari-incrassata minute sed dense stipitato-glandulosa apice sparse ciliata; radii numerosi angusti sicco laete rosei; achenia compressa 2-nervia subappresse hirsuta; pappus duplex, exterior e squamellis lineari-oblongis 0.5 mm longis, interior e setis ca. 12 fragilibus ca. 3 mm longis compositus.

Basal leaves 4–5 cm long including petiole, the blade about 10–14 mm long, 2–2.5 mm wide, gradually decurrent on the petiole, this at base widened and 1-nerved; stems leafy to above the middle, the upper leaves similar to the lower but smaller; petiole bases of old leaves persistent at base of stem; peduncle (naked tip of stem) about 3 5–5.5 cm long, very slender, striate like the stem; disk (as pressed) 6–8 mm high, 10–12 mm thick; rays 40 and more, the tube 2 mm long, puberulous above, the lamina linear, 3-denticulate, 4-nerved, 10 mm long, 1–1.3 mm wide; disk corollas yellow, glabrous on tube and teeth, densely puberulous on lower half of throat, 3.4 mm long (tube 0.6 mm, throat cylindric, 2.3 mm, teeth 0.5 mm long); achenes oblong, 1.5–1.8 mm long; inner pappus of about 12–14 fragile hispidulous bristles, the outer of about as many linear or linear-oblong paleae, sometimes acute and entire, sometimes obtusish and few-dentate, all free; style appendages deltoid, obtusish, hispidulous.

ARIZONA: Without definite locality, 1869, *E. Palmer* (type no. 45116, U S. Nat. Herb.).

The data for Edward Palmer's "Arizona" specimens of 1869 are so uncertain that this plant is ascribed to the State with some hesitation. However, it appears to represent a species so distinct and unique as to merit description despite some doubt about its habitat. In most of its characters it resembles *E. concinnus* (Hook. and Arn.) Torr. and Gray so strongly that it might almost be considered an essentially glabrous form of that species. The material consists of two specimens, each with a decidedly woody, erect, once- or twice-forked base about 3 cm high, possibly representing the upper part of a much-branched caudex, clothed above with the marcescent bases of the petioles of fallen leaves, and emitting several erect flowering stems. The glands of stem and leaves are so minute that even under a lens the plant appears glabrous or essentially so except on the involucre and upper part of the peduncles, and even there the glands are very small; the leaves for the most part seem to be completely glabrous.

Erigeron brandegei Gray, still known definitely only from the single scanty specimen collected by T. S. Brandegee on adobe plains, southwest Colorado, in 1875, is intermediate between *E. concinnus* and *E. perglaber*. The extreme base of the specimen (a single stem with abortive terminal head and four 1-headed branches) is not present; the whole plant is finely and sparsely subglandular-puberulous and more densely hirsute with mostly spreading hairs, especially on the lower half of stem, leaves, and apex of peduncles; the involucre is finely subglandular-puberulous, and sparsely spreading-hirsute on the outer phyllaries; and the phyllaries are broader (0.5–0 8 mm) than in *E. perglaber*. The pappus squamellae are long (often 1–2 mm), and irregularly united with each other and with the inner bristles in a manner that certainly indicates an abnormal condition, as Gray suggested.

Galinsoga semicalva var. **percalva** Blake, var. nov.

Achenia radii et disci glabra epapposa.

ARIZONA: Santa Rita Mountains, Pima County, *David Griffiths & J. J. Thornber* 162 (type no. 497226, U. S. Nat. Herb.); Santa Rita Mountains, 1912, *E O Wooton* (U. S. Nat. Herb.).

With the narrow leaves and other characters of *Galinsoga semicalva* (Gray) St. John and White, but with achenes of both ray and disk glabrous and completely without pappus. In the typical form the disk achenes are hispidulous and bear a well-developed pappus, those of the ray glabrous or usually hispidulous above on the inner face and provided with a reduced pappus or none.

Actinea quinquesquamata (Rydb.) Blake

Hymenoxys cooperi subsp. *grayi* Cockerell, Bull. Torrey Club 31: 495. 1904
Hymenoxys quinquesquamata Rydb. N. Amer. Fl. 34: 114. 1915.

Gaillardia arizonica Gray var. **pringlei** (Rydb.) Blake

Gaillardia pringlei Rydb. N. Amer. Fl. 34: 139. 1915.
Gaillardia arizonica pringlei Blake in Tidestrom, Contr. U. S. Nat. Herb. 25: 598. 1925.

Artemisia carruthii Wood var. **wrightii** (Gray) Blake

Artemisia wrightii Gray, Proc. Amer. Acad. 19: 48. 1883.
Artemisia vulgaris subsp. *wrightii* Hall and Clements, Phylogen. Meth. Taxon. 80. 1923.

Artemisia dracunculoides Pursh var. **dracunculina** (S. Wats). Blake

Artemisia dracunculina S. Wats. Proc. Amer. Acad. 23: 279. 1888.
Artemisia dracunculus subsp. *dracunculina* Hall and Clements, Phylogen. Meth. Taxon. 116. 1923.

BOTANY.—*Arizona plants: A new variety and new names and combinations.*[1]

ROBERT H. PEEBLES, U. S. Bureau of Plant Industry, and LOUIS C. WHEELER, University of Missouri. (Communicated by T. H. KEARNEY.)

In recent numbers of this JOURNAL, several novelties were published by the writers and their collaborators, in the course of preparation of a flora of Arizona. The need has arisen since for publication of a few additional names.

Ephedra cutleri Peebles, nom. nov.

Ephedra coryi var. *viscida* Cutler, Ann. Missouri Bot. Gard. 26: 413. 1939.

In view of the ease with which *E. cutleri* can be recognized, its great abundance, dominating habit, comparatively wide distribution, and doubtful affinity with *E. coryi* Reed, it seems proper to regard it as a specific entity. According to Cutler (*ibid.*), this *Ephedra* occurs in southwestern Colorado, southeastern Utah, northwestern New Mexico, and northeastern Arizona, thus being geographically distinct from *E. coryi*, which has been reported only from western Texas. Morphologically, it differs from *E. coryi* in having the aerial stems more or less woody, frequently branched, often viscid, and the bracts of the mature fruiting cones not fleshy. *E. cutleri* seems to be most closely related to *E. viridis* Coville, although differing from that species in having shorter, often viscid stems, and long-peduncled ovulate cones. The geographical distribution of *E. cutleri* and *E. viridis* are mainly distinct, although both species occur in Coconino County, Ariz.

Dalea amoena Wats. var. **pubescens** (Parish) Peebles, comb. nov.

Parosela johnsoni var. *pubescens* Parish, Bot Gaz. 55: 308. 1913.

Psorodendron pubescens Rydb. N. Amer. Fl. 24: 44. 1919.

Euphorbia palmeri S. Wats. var. **subpubens** (Engelm.) Wheeler, comb. nov.

Euphorbia subpubens Engelm. in S. Wats. Bot. Calif. 2: 76. 1880.

Euphorbia incisa Engelm. var. **mollis** (Norton) Wheeler, comb. nov.

Euphorbia schizoloba Engelm. var *mollis* Norton, N. Amer. Euphorbia sect. Tithymalus. 43. 1899 (preprint from Ann. Rep. Missouri Bot. Gard. 11: 127. 1900).

Opuntia whipplei Engelm. & Bigel. var. **enodis** Peebles, var. nov.

A forma typica tuberculis baccae latis humilibus distinguitur.

Type: North end of Hualpai Mountain, Mohave County, Ariz., altitude 4,200 feet, *Peebles SF 883*, April 19, 1935.

Although the fruit of *Opuntia whipplei* is described as not being very prominently tuberculate, Engelmann and Bigelow evidently used the term in a comparative sense. The illustration accompanying the original description shows the fruit to be rather strongly tuberuclate, and it was thus interpreted by Britton and Rose in their monograph of the Cactaceae. The usual form of this common Arizona species bears prominent, high, laterally compressed tubercles. In the variety *enodis* the tubercles are broad, low, and not prominent. The variety is known only from the type collection.

Sterile fruits occur in typical *O. whipplei* and in var. *enodis*, but the presence or absence of seeds does not materially affect the appearance of the berry.

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[1] Received August 6, 1940.

ZOOLOGY.—*The nematode genus* Raillietnema *Travassos, 1927.*[1]

A. C. WALTON, Knox College. (Communicated by E. W. PRICE.)

The genus *Raillietnema* was established by Travassos in 1927 for those species of cosmocercoid nematodes that show simple basically amphidelphic uteri, a small number of relatively large ova, a vulva opening posterior to the midregion of the body, a much simplified male reproductive structure, subequal spicules, and a very small accessory piece. *Oxysomatium simples* Travassos, 1925—from *Hyla faber*, Brazil—was made the type species. In 1931 Travassos added *Aplectana loveridgei* Sandground, 1928—from *Scolecomorphus vittatus*, Africa—to the genus, and the present paper adds a third species. Semenow (1929) added *Oxyuris praeputialis* Skrjabin, 1916, to the genus, but this form lacks an accessory piece and has complex ovarian coils ending in uteri containing many eggs of relatively small size. As was pointed out earlier (Walton, 1933) this species must be excluded from the genus *Raillietnema* as it is now constituted.

Restudy of material believed to be *Raillietnema simples* (from *Hyla faber*—Brazil) and *R. loveridgei* (from *Scolecomorphus unicolor*—Tanganyika Territory, Africa) supports the grouping of the two species into a single genus, and the finding of a third species with similar characteristics in *Scolecomorphus uluguruensis* (from Lyingwa, Tanganyika Territory, Africa) seems to justify the establishment of *Raillietnema* as a valid genus of the family Cosmocercidae.

Raillietnema simples (Travassos, 1925) Travassos, 1927 Fig. 1

Examination of both male and female material from the type host, *Hyla faber* (from Brazil), adds little to the original description except to point out that the male possesses very narrow caudal alae, which extend from just in front of the cloaca to a point midway along the length of the tail, and that these alae are supported by 4 of the 10 pairs of papillae characteristic of the species. Narrow lateral ridges are present in both sexes, extending from the anterior esophageal to the postanal region. This character is present in all three species of the genus. The excretory vesicle is heavily cuticularized, as it is in the other two species, but is characteristically cylindrical, not spherical, in form.

Male.—Length, 1.6–1.75 mm; greatest width, 0.076–0.082 mm; pharynx length, 0.029–0.032 mm; esophagus length, 0.37–0.405 mm; esophageal bulb measures 0.052–0.057 mm by 0.052–0.057 mm, with a neck 0.047–0.05 mm in length; head-nerve ring distance, 0.195–0.21 mm; head-excretory pore distance, 0.385–0.405 mm; cloaca-tail distance, 0.165–0.171 mm; spicule length, 0.218–0.221 mm; accessory piece length, 0.0159–0.0163 mm; caudal papillae arrangement, 2 pairs precloacal and 8 pairs postcloacal, with 1 pair of precloacals and 3 pairs of postcloacals supporting the caudal alae.

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[1] Received June 20, 1940. Contribution from the Biological Laboratories of Knox College, no. 68.

One median unpaired precloacal papillus is present. Narrow lateral ridges extend almost the entire length of the body.

Female.—Length, 2.35–2.72 mm; width at vulva, 0.105–0.141 mm; pharynx length, 0.034–0.038 mm; esophagus length, 0.49–0.51 mm; esophageal bulb measures 0.07–0.072 mm by 0.07–0.072 mm, with a neck 0.05–0.053 mm in length; head-nerve ring distance, 0.245–0.251 mm; head-excretory pore distance, 0.48–0.51 mm; anus-tail distance, 0.22–0.245 mm; vulva-tail distance, 1.19–1.38 mm; larvated eggs measure 0.09–0.12 mm by 0.22–0.24 mm; 2–4 eggs in each uterus. Narrow lateral ridges along almost the entire length of the body.

Host.—*Hyla faber*—Brazil.

Habitat.—Large intestine and the lower end of the small intestine of the host.

Raillietnema loveridgei (Sandground, 1928) Travassos, 1931 Fig. 2

Study of both male and female material collected from three specimens of *Scolecomorphus unicolor* (taken July 1939, at Magrotto Mountain, Tanganyika Territory, Africa) adds but little to the original description. Both sexes have narrow lateral ridges extending almost the entire length of the body, and the excretory vesicle of each is subspherical in shape. One pair of precloacal and one pair of postcloacal papillae support the caudal alae in the male; the third pair of papillae is postalar in position. The number of ova in each uterus is somewhat greater than in *R. simplex*, but is still relatively low.

Male.—Length, 1.81–2.01 mm; greatest width, 0.109–0.12 mm; pharynx length, 0.021–0.032 mm; esophagus length, 0.363–0.4 mm; esophageal bulb measures 0.055–0.08 mm by 0.055–0.08 mm, with a neck 0.06–0.07 mm in length; head-nerve ring distance, 0.145–0.15 mm; head-excretory pore distance, 0.326–0.363 mm; cloaca-tail distance, 0.07–0.08 mm; spicule length, 0.175–0.2 mm; accessory piece length, 0.035–0.039 mm; caudal papillae arrangement, one pair precloacal and two pairs postcloacal, with the last pair caudad to the alae. One median unpaired precloacal papillus is present. Narrow lateral ridges extend almost the entire length of the body.

Female.—Length, 2.141–3.025 mm; width at vulva, 0.127–0.15 mm; pharynx length, 0.024–0.03 mm; esophagus length, 0.34–0.42 mm; esophageal bulb measures 0.075–0.09 mm by 0.075–0.09 mm, with a neck 0.07–0.085 mm in length; head-nerve ring distance, 0.152–0.175 mm; head-excretory pore distance, 0.35–0.375 mm; anus-tail distance, 0.09–0.115 mm; vulva-tail distance, 0.6–0.95 mm; larvated eggs measure 0.076–0.1 mm by 0.14–0.16 mm; 6–7 eggs in each of the uteri. Narrow lateral ridges extend almost the entire length of the body.

Hosts.—*Scolecomorphus unicolor*, *S. vittatus*—Africa (Tanganyika Territory).

Habitat.—Large intestine of the host.

Raillietnema multipapillata, n. sp. Fig. 3

Scolecomorphus uluguruensis (taken at an altitude of 8,000 feet near Lyingwa, Tanganyika Territory, Africa, in October, 1926) is the host for a third species of *Raillietnema*. Both male and female specimens are available for study.

Male.—Length, 1.82–1.83 mm; greatest width, 0.09–0.1 mm; pharynx length, 0.027–0.03 mm; esophagus length, 0.33–0.345 mm; esophageal bulb measures 0.07–0.08 mm by 0.07–0.08 mm, with a neck 0.07–0.075 mm in

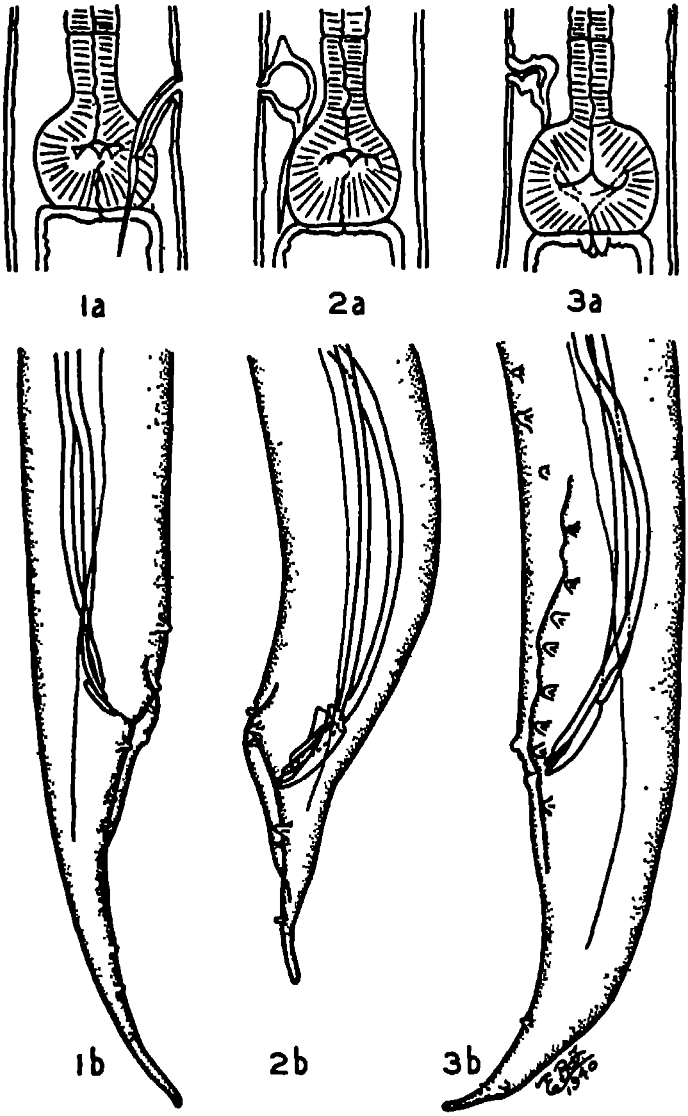

Fig. 1.—*Raillietnema simplex*. *a*, Esophageo-intestinal junction; *b*, lateral view of tail of male. Fig. 2. *Raillietnema loveridgei*: *a*, Esophageo-intestinal junction; *b*, lateral view of tail of male. Fig. 3. *Raillietnema multipapillata*: *a*, Esophageo-intestinal junction; *b*, lateral view of tail of male. (All drawn to the same scale.)

length; head-nerve ring distance, 0.17–0.178 mm; head-excretory pore distance, 0.28–0.3 mm; cloaca-tail distance, 0.12–0.13 mm; spicule length, 0.28–0.291 mm; accessory piece length, 0.036–0.041 mm; caudal papillae arrangement, 10 pairs precloacal and 4 pairs postcloacal, with 7 pairs of precloacals and 1 pair of postcloacals supporting the narrow caudal alae. One median unpaired precloacal papillus present. Narrow lateral ridges extend practically the entire length of the body.

Female.—Length, 2.582–2.702 mm; width at vulva, 0.232–0.261 mm; pharynx length, 0.033–0.037 mm; esophagus length, 0.36–0.4 mm; esophageal bulb measures 0.1–0.125 mm by 0.1–0.125 mm, with a neck 0.1–0.13 mm in length; head-nerve ring distance, 0.175–0.185 mm; head-excretory pore distance, 0.36–0.371 mm; anus-tail distance, 0.161–0.169 mm; vulva-tail distance, 1.075–1.092 mm; nonlarvated eggs measure 0 109–0.113 mm by 0.125–0.13 mm; 6–8 eggs in each of the uteri. Narrow lateral ridges extend almost the entire length of the body.

Host.—*Scolecomorphus uluguruensis*—Tanganyika Territory, Africa.

Habitat.—Large intestine of host.

Type specimens.—Cotypes are deposited in the collections of the United States National Museum (no. 42090).

Discussion.— *Raillietnema multipapillata* may be separated from the other two members of the genus on the bases of: (1) A larger total number of caudal papilla, (2) by the greater number of papillae supporting the caudal alae, (3) by the larger number of smaller ova, (4) by the longer spicules, and (5) by the distinctive form of the heavily cuticularized excretory vesicle. *R. loveridgei* has the least number of caudal papillae and the shortest caudal alae, the shortest spicules, and the most complex accessory piece of the three species. The number of ova is intermediate and the excretory vesicle is subspherical in form. In *R. simples* the number of caudal papillae and the size of the caudal alae increase, the spicules are longer, the accessory piece is much reduced, the number of ova is low, and the excretory vesicle is a short cylindrical structure. *R. magnipapillata* has the greatest number of caudal papillae, the longest caudal alae, the longest spicules, a large accessory piece of simple structure, a larger number of smaller ova, and an excretory vesicle shaped like a collapsed sphere with very heavy walls.

The genus *Raillietnema* at present consists of three species, two from African examples of the Apoda and one from a Brazilian tree frog. It seems to act as a connecting link between the cosmopolitan *Oxysomatium-Aplectana* group of quite complex species, on the one hand, and the extremely simplified, secondarily evolved, and geographically localized *Schrankia* species, on the other. The species of this latter genus are reported only from one species of *Leptodactylus* (*L. pentadactylus*) from Brazil. Only one or two eggs seem to mature at any one time in the members of the genus, and the number of spermatozoa is likewise greatly reduced. *Oxysomatium* appears to be nearer the original stem of the cosmocercoids, and from this base has evolved *Raillietnema* and then *Schrankia*. The reduction in the complexity of the reproductive systems is regarded as evidence of secondary, not primary, simplicity of the genera.

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ENTOMOLOGY.—*The North American empoascan leafhoppers of the* alboneura *group* (*Homoptera-Cicadellidae*).[1] NANCY H. WHEELER,[2] U. S. Bureau of Entomology and Plant Quarantine. (Communicated by J. S. WADE.)

In 1898, Gillette,[3] using external characters only, described the widely distributed American leafhopper *Empoasca alboneura.* At the same time he also described two other species of *Empoasca, mexicana* and *tumida,* having certain external characters similar to those of *alboneura.* In the revision of the genus *Empoasca,* DeLong[4] redescribed the external characters of *alboneura* and included a description and illustrations of the internal male genitalia of this species, pointing out that *tumida* was a synonym and placing *alboneura* next to *aspersa* in the subgenus *Hebata.* Later, DeLong and Davidson[5] described and illustrated *confusa,* which externally closely resembles *alboneura* but internally is quite distinct.

The most distinctive external characters of *alboneura* and closely related species are the more or less bluntly rounded crown and the pale nervures of the forewings, the latter, by contrast, giving to most of the species of this group a more or less striped appearance. The species are all rather robust and range from 2.5 to 3.3 mm in length. In size and shape they are somewhat similar to the species of the *aspersa* group,[6] but are of a duller green color and lack the mosaic pattern of the forewings that is characteristic of the *aspersa* group.

With a view to bringing together the various species of this rather homogeneous group, of which *alboneura* is considered typical, a careful study has been made of the specimens standing under the name *alboneura* in the United States National Museum collection. As a result, the type series has been found to be mixed, containing both *alboneura* and *confusa*. From a further examination of available collections for specimens resembling *alboneura*, two apparently undescribed species have been segregated. The group is now known to contain five different species, three of which have been previously described and illustrated.[7] For convenience, however, illustrations and descriptions of all the species of the *alboneura* group now known to occur in North America are included in this paper, together with some synonymical changes. A key to the males of the group is also offered as an aid in separating the various species.

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[1] Received June 19, 1940.

[2] The writer expresses her appreciation to P. W. Oman, of the Division of Insect Identification, Bureau of Entomology and Plant Quarantine, for his cooperation and for furnishing specimens of species recognized by him as undescribed, and to Dr. R. H. Davidson and Dr. D. M. DeLong for the loan of valuable type material.

[3] Proc. U. S. Nat. Mus. 20: 743–744. 1898.

[4] U. S. Dept. Agr. Tech. Bull. 231: 35. 1931.

[5] Ohio Journ. Sci. 36: 229. 1936.

[6] Proc. Ent. Soc. Washington 40: 133–147. 1938.

KEY TO THE SPECIES OF THE ALBONEURA GROUP

1. Lateral processes converging distally . . . 4. *confusa* DeL. and D.
Lateral processes diverging distally . . . 2

2 (1). Dorsal spine vestigial. Lateral process very broad basally, in lateral view tapering abruptly and strongly curved dorsad . . . 1. *sonorana*, n. sp.
Dorsal spine prominent. Lateral process relatively slender basally, in lateral view more or less sinuate, with sides almost parallel to near tapered apex . . . 3

3 (2). Aedeagus with two pairs of spinelike processes projecting dorsocaudad. Apex of dorsal spine short, bluntly pointed 5. *mexicana* Gill.
Aedeagus without spinelike processes. Apex of dorsal spine attenuated or sharply pointed . . . 4

4 (3). Dorsal spine sickle-shaped, apex attenuated. Lateral process, in lateral view, with both proximal and distal portions definitely sinuate; distal portion convexly curved on dorsal margin 3. *alboneura* Gill.
Dorsal spine not sickle-shaped, broad basally, abruptly narrowed medially, and terminating in a slender, pointed, toelike projection. Lateral process, in lateral view, with proximal and distal portions only slightly curved; distal portion concavely curved on dorsal margin . . . 2. *stylata*, n. sp.

Empoasca sonorana, n. sp. Fig. 1

Resembling *alboneura* in size and general structure, but lacking the strongly contrasting veins of forewing; lateral process very broad basally and dorsal spine vestigial. Length, 3.25 mm.

External characters.—General color pale sordid green; head, thorax, and scutellum sometimes with irregular, paler areas. Posterior margin of seventh sternite of female faintly incised medially and faintly sinuate each side of median incision.

Male internal structures.—Lateral process very broad basally, tapering rather abruptly but evenly, in lateral view to sharply pointed apex curved dorsad, in ventral view to bluntly pointed apex directed caudolaterad. Style long, relatively slender, gradually tapering to sharply pointed apex directed caudolaterad. Dorsal spine vestigial. Aedeagus slender, extending upward from base, then bent directly caudad and broadly curved dorsad. Sternal apodemes rudimentary.

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[7] Subsequent to the submission of this paper for publication it was found that *Empoasca knulli*, described by Davidson and DeLong (Ohio Journ. Sci. 39: 111. 1939) is a member of the *alboneura* group. The original description, in which the species was compared with *similis* and *bicuspida* (members of the *aspersa* and *fabae* groups, respectively), appeared without accompanying illustrations. *Empoasca knulli* may be differentiated from the other members of the *alboneura* group, here treated, by the bifurcate dorsal spine.

Holotype male, allotype female, and 3 male and 20 female paratypes from Cajene, Sonora, Mexico, June 1, 1927, A. W. Morrill, collector.

Type, U.S.N.M. no. 54190.

Empoasca stylata, n. sp. Fig. 2

Related to *alboneura*, but larger, with venation of wings less conspicuous, dorsal spine stouter, and lateral process not broadened distally in ventral view. Length, 3.3 mm.

External characters.—General ground color pale sordid green tinged with fuscous; venation of wings obscure except apically. Crown with ivory spots and an ivory median line. Pronotum marked with three irregular ivory areas anteriorly.

Male internal structures.—Lateral process long, slender, with sides almost parallel to near pointed apex, with distal portion in lateral view concavely curved on dorsal margin and directed dorsocaudad, in ventral view curved caudolaterad. Style long, relatively broad at base, with tip bent laterad. Dorsal spine strongly curved first caudad, then ventrad and cephalad, broad basally, narrowed medially, and terminating in a slender, pointed, toelike projection extending cephalomesad from ventrocephalic margin. Aedeagus stout, process for muscular attachment extending at nearly right angles to shaft. Sternal apodemes fuscous, large, sacklike, and rounded apically.

Holotype male and one male paratype from Cajon Pass, Calif., June 6, 1935, collected by P. W. Oman, and one male paratype from Los Angeles, County, Calif., collected by D. W. Coquillett. The last-mentioned specimen was standing under the name *alboneura* in the Museum collection.

Type, U. S. N. M. no. 54191.

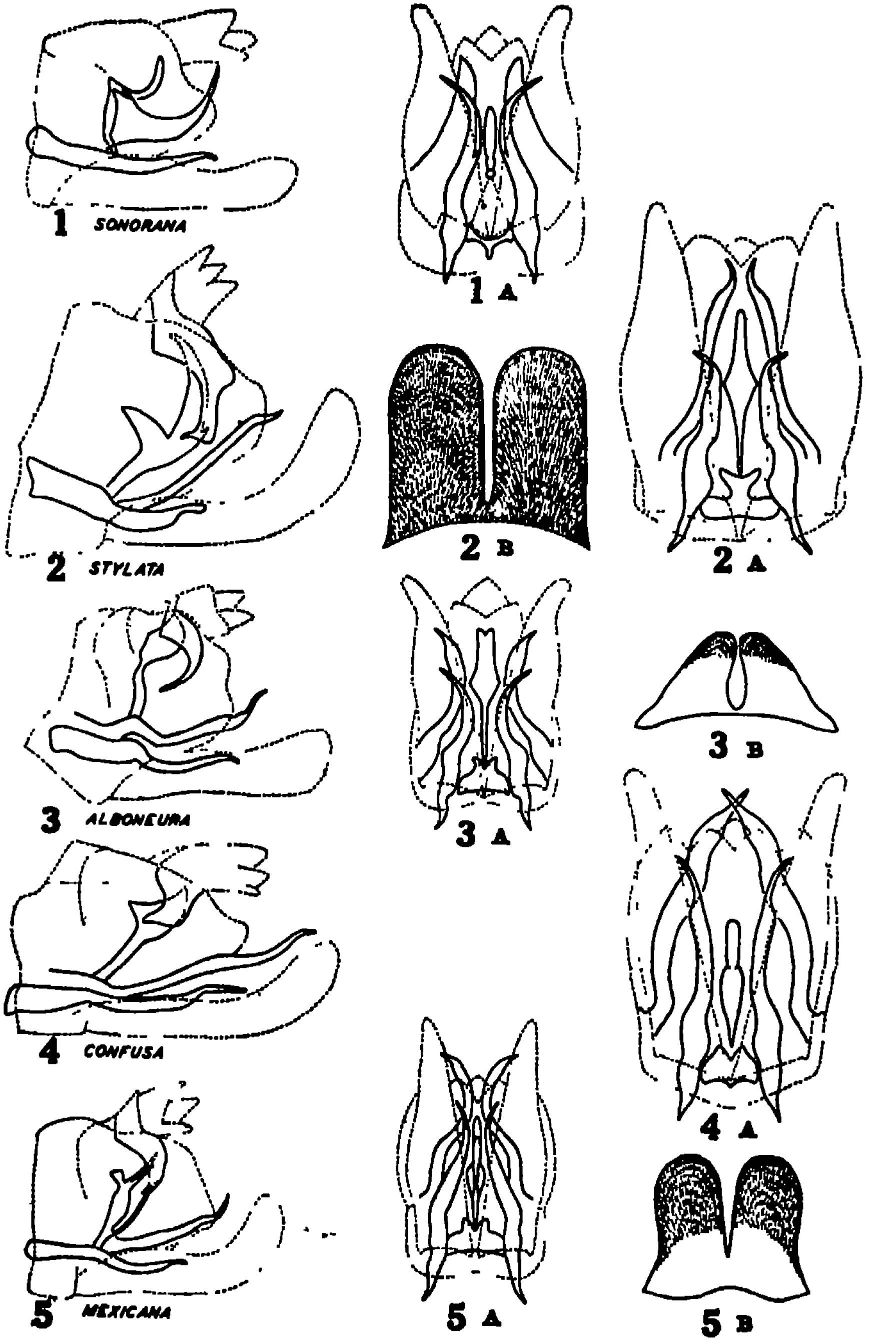
Empoasca alboneura Gillette Fig. 3

Empoasca alboneura Gillette, Proc. U. S. Nat. Mus. 20: 743–744. 1898.

A relatively robust, dull-green species characterized by the pale nervures of the forewings, giving a conspicuously striped appearance. Lateral processes definitely sinuate and diverging distally; spine stout and sickle-shaped. Length, 2.5 to 3.5 mm.

External characters.—General color varying from yellowish green tinged with orange to dull green tinged with brown, veins pale and conspicuous. Crown relatively broad, bluntly rounded and slightly produced, with a light median stripe and an oblique dash on each side near the eye. Posterior margin of seventh sternite of female produced and rounded medially, with a very shallow and broad lateral emargination.

Male internal structures.—Lateral process in lateral view long, relatively slender and sinuate, with distal portion convexly curved on dorsal margin and tapered to pointed apex directed dorsocaudad; in ventral view, curving mesad to near middle, then laterad, with distal portion slightly broadened, then narrowed to pointed apex directed caudolaterad. Style long, with basal portion relatively broad, sinuate and abruptly narrowed near middle, with apical portion broadly curved and gradually tapered to bluntly pointed apex directed caudolaterad. Dorsal spine relatively stout and sickle-shaped,



Figs. 1–5.—Lateral and ventral (A) views of male genital capsule and ventral view (B) of sternal apodemes of (1) *Empoasca sonorana*, n. sp.; (2) *E. stylata*, n. sp.; (3) *E. alboneura* Gill.; (4) *E. confusa* DeL. and D.; and (5) *E. mexicana* Gill. ×ca. 60.

broadly curved and evenly tapered to attenuated apex directed ventrocephalad. Aedeagus broad distally. Sternal apodemes rather small, narrowed on lateral margins to bluntly rounded and slightly fuscous apices.

Originally described by Gillette from 15 females and 9 males from Mississippi Agricultural College, 2 specimens from Virginia, and 7 specimens from Colorado; specimens were also recorded from "D. C.," and from the U. S. National Museum marked "Va.," "Los Angeles, Calif., Coquillett," "Nevada Co., Cal., Sept.," "Horace, Ks., July 28," and "Neb.," the type being designated "No. 3437 U. S. N. M."

The type series now extant in the U. S. National Museum consists of two females with the Type no. 3437, one labeled Horace, Kans., and the other Lakin (?), Kans. Therefore, Gillette's cotype female in the U. S. National Museum (Type no. 3437) from Horace, Kans., is here designated lectotype.

More recently this species has been identified in miscellaneous collections from Alabama, California, Colorado, Connecticut, District of Columbia, Kansas, Kentucky, Maryland, Mexico, Missouri, Montana, Nevada, New Mexico, New York, North Carolina, Ohio, Oregon, Pennsylvania, Tennessee, Texas, Utah, Virginia, and Wyoming.

In the original description Gillette reported *alboneura* from "native plants" and from plum in Colorado. Later, DeLong[4] recorded this species as "distributed almost throughout the United States on herbaceous plants." Other records have been procured, from collections in various localities, of the occurrence of *alboneura* on alfalfa, *Anthemis cotula*, *Artemisia*, artichokes, aster, *Chrysothamnus*, giant ragweed, and white pine. This species has also been taken in trap lights at Arlington, Va., Knoxville, Tenn., and Richfield, Utah.

The accompanying illustrations and descriptions of this species have been made from a study and comparison of a number of males and females from series collected both in the East and in the West. There seems to be some variation in this species, both externally (in size and coloration) and internally (in the breadth and sinuation of the apical portion of the lateral process), but no greater differences have been noted between eastern and western specimens than between specimens of a series from the same locality and date of collection.

Empoasca confusa DeLong and Davidson Fig. 4

Empoasca confusa DeLong and Davidson, Ohio Journ. Sci. 36: 229. 1936.

Superficially resembling *alboneura* but less conspicuously striped and less robust, with crown narrower and only slightly produced; lateral processes sinuate but converging distally. Length, 3 mm.

External characters.—General color fuscous-green, with venation of forewing pale. Posterior margin of seventh sternite of female produced and broadly rounded medially, with a small notch, on each side, laterally.

Male internal structures.—Lateral process long and sinuate; in ventral view broad, with distal portion narrowed to long slender point directed caudomesad; in lateral view more slender and tapered gradually to pointed apex directed caudad. Style relatively long, broad at base, with distal portion abruptly narrowed to long, slender apex directed caudolaterad in ventral view. Dorsal spine short, broad, concave on anterior margin, with a bluntly pointed, toelike projection extending cephalad from ventrocephalic margin. Aedeagus simple and relatively slender. Sternal apodemes rudimentary.

Originally described from a single male collected at Burns, Oreg., holotype male in the DeLong collection. The male and female herein treated, the former redescribed and reillustrated, are from a series of 18 males and 48 females collected at Mount Shasta, Calif., by R. H. Beamer. Other males and females at hand are from the following localities: CALIFORNIA: Bray (Oman). COLORADO: Durango, Livermore (Oman); Mesa Verde (Beamer); Poudre River Canyon (Sanderson). NEVADA: Reno (Beamer). OREGON: Bend (Oman). WASHINGTON: Cliffdell (Beamer); Mount Rainier (Oman). Four females of this species from Nevada County, Calif., were found under *alboneura* type no. 3437 in the U. S. National Museum collection.

Empoasca mexicana Gillette Fig. 5

Empoasca mexicana Gillette, Proc. U. S. Nat. Mus. 20: 737–738. 1898.
Empoasca tumida Gillette, Proc. U. S. Nat. Mus. 20: 744. 1898.
Empoasca bitubera DeLong, Ohio Journ. Sci. 32: 395. 1932.

One of the smallest species of the *alboneura* group, with crown rounded, but slightly more produced than in *alboneura*. Aedeagus with two pairs of spinelike processes. Length, 2.5 to 2.75 mm.

External characters.—Color yellowish to fuscous-green, with veins of forewing pale but not so distinct as in *alboneura*, except apically. Posterior margin of seventh sternite of female slightly produced and rounded medially, with slight lateral emargination.

Male internal structures.—Lateral process relatively long, broad, and tapered apically; in lateral view extending dorsocaudad, with distal portion narrowed on dorsal margin and curved upward; in ventral view sinuate, curved mesad about middle, with distal portion broadened slightly, then tapered to sharply pointed apex curved laterad. Dorsal spine broad at base, broadly curved caudoventrad, with bluntly pointed apex directed cephalomesad. Aedeagus unusual, having a pair of long, narrow, spinelike processes projecting dorsocaudad from near base and another, shorter pair arising similarly but more dorsally. Sternal apodemes medium sized, slightly fuscous, and rounded apically.

This species was originally described by Gillette from five females collected near Veracruz, Mexico, and was given U. S. N. M. type no. 3430. Later, DeLong redescribed *mexicana*, in the absence of Gillette's type material, from specimens in the collection of the U. S. National Museum, labeled Marfa, Tex., June 5, 1908, Mitchell and Cushman, collectors. As previously indicated by the writer,[6] from an examination of this series now extant, the external markings and internal structures of the male were found to be identical with those described and figured later by DeLong for *bitubera*, and *bitubera*, therefore, was placed as a synonym of *mexicana*.

An examination of the type of *tumida*, a female in the U. S. National Museum, labeled "Colo. 1658" (type no. 3438), has shown this form to be specifically identical with females from Marfa, Tex., identified as *mexicana* by DeLong. Therefore, *Empoasca tumida* is also placed as a synonym of *E. mexicana*.

For the sake of uniformity, *mexicana* is herein redescribed and reillustrated from the series collected at Marfa, Tex., June 5, 1908, now consisting of 1 male (dissected), 3 females, and 2 specimens with abdomens missing. Other material has been examined from various localities in Arizona, California, Colorado, Nevada, New Mexico, Texas, and Utah.

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[6] Journ. Washington Acad. Sci. 29: 300. 1939.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE ACADEMY

362D MEETING OF THE BOARD OF MANAGERS

The 362d meeting of the Board of Managers was held at the Cosmos Club on Friday, June 28, 1940. President Crittenden called the meeting to order at 8:04 P.M. There were 11 present as follows:

E. C. Crittenden
F. D. Rossini
F. C. Kracek
H. S. Rappleye
A. H. Clark
P. C. Whitney
E. W. Price
C. L. Garner
W. W. Diehl
and by invitation
F. G. Brickwedde
N. R. Smith

President Crittenden announced the appointment of the following committees:

Committees on Awards for Scientific Achievement for the Calendar Year 1941

For the Biological Sciences

A. H. Clark, chairman
F. O. Coe
J. M. Cooper
H. A. Edson
E. A. Goldman
I. T. Haig
C. F. W. Muesebeck
H. W. Schoening
G. Steiner
A. Wetmore

For the Physical Sciences

O. H. Gish, chairman
A. K. Balls
F. S. Brackett
W. E. Deming
H. E. McComb
F. L. Mohler
W. T. Schaller
J. H. Taylor
O. R. Wulf
E. G. Zies

For the Engineering Sciences

F. M. Defandorf, chairman
C. H. Birdseye
H. L. Curtis
H. G. Dorsey
H. N. Eaton
A. C. Fieldner
H. C. Hayes
G. W. Musgrave
W. N. Sparhawk

Committee on Meetings to Serve until June 1941

C. L. Garner, chairman
R. E. Gibson
L. V. Judson
W. C. Lowdermilk
P. A. Smith
Charles Thom

Chairman N. R. Smith, of the Committee on the Records of the Academy, presented the following recommendations, which were accepted by the Board with instructions to the committee to prepare the appropriate amendments to the bylaws for submission to the members:

1. That there be created the office of Archivist, whose duties would be: *First*, to go over the present accumulation of material, sort out the important records, and

arrange and keep them in permanent order; *second*, accept and care for the records turned over to him by the Corresponding Secretary each year.

2. That the present duties of the Corresponding Secretary as regards the maintenance of the Academy's permanent records be transferred to the Archivist.

3. That the office of Recording Secretary be abolished, his purely secretarial duties transferred to the Corresponding Secretary, and such permanent records as are now kept by him transferred to the Archivist

4. That the name of the office of Corresponding Secretary be changed to Secretary.

Under the proposed plan, the Archivist would have charge of the following records which are now in the hands of the Corresponding Secretary·

1 A set of the Proceedings of the ACADEMY.
2 A set of the bound Journals.
3 A set of the Directories (incomplete, 1900 to 1910).
4. Permanent Minutes of the Board of Managers.
5 A record of Academy officers and organization.
6 Nominations for membership.
7. Important correspondence
8. Material of permanent interest, medals, invitations, etc.

Your committee further recommends that the Archivist be appointed by the President for a period of three years and that the person selected for the position be one who is interested in this type of work and who has had appropriate experience in the affairs of the ACADEMY.

On the recommendation of the Committee, of which H. L. CURTIS was chairman and CHARLES THOM and P. C. WHITNEY members, the Board approved for presentation to the ACADEMY a revision of the bylaws entitled "Amendment to modify the procedure for amending the bylaws":

ARTICLE IX. Delete lines 1 to 10 and insert the following:

"Amendments to these bylaws shall be proposed by the Board of Managers and adopted by a letter ballot of the members of the ACADEMY, with a two-thirds majority of those voting being required for adoption When a proposed amendment is sent to the members, there shall also be submitted a statement of the reasons for the proposed amendment. The ballots shall be counted one month after mailing to the members.

"Any affiliated society or any group of ten or more members may request, in writing, the Board of Managers to propose an amendment. The action of the Board in accepting or rejecting this request shall be by a verbal (yea and nay) vote on a roll call, and the complete roll call shall be entered in the minutes of the meeting."

The Corresponding Secretary presented for the Committee on Membership the nominations of 17 persons; one resident and 16 nonresident.

After fixing the next meeting for September or October, the Board adjourned at 9:50 P.M.

GEOLOGICAL SOCIETY

569TH MEETING

The 569th meeting of the Society was held at the Cosmos Club, January 11, 1939, President J. B. MERTIE, JR., presiding.

Informal communications.—T. S. KESLER described some unusual rock structures in northern Georgia.

Program.—C. WYTHE COOKE: *Neptune's racetracks.*

E. CALLAGHAN: *Recent fault scarps in the western part of the Great Basin.*

C. B. HUNT: *Pediments around the Henry Mountains, Utah.*

570TH MEETING

The 570th meeting of the Society was held at the Cosmos Club, January 25, 1939, President J. B. MERTIE, JR., presiding.

Program.—F. P. SHEPARD: *Nondepositional environments off the California coast.*—Bottom sampling by P. D. Trask and reports of bottom conditions coming from the work of the U. S. Coast and Geodetic Survey gave the impression that there were considerable areas off the California coast where deposition is either very slow or nonexistent. Recent work on the *E. W. Scripps,* involving dredging and coring operations over a wide area off this coast, has shown that these nondepositional surfaces are widespread, that they are associated with various topographic environments, and that all depths up to 3,500 meters are involved. The environments having either rock bottom or sediment that appears to be too coarse to be introduced at the present time include: Banks or submarine mountains rising above any part of the sea floor; steep submarine slopes; portions of the continental shelves; and the walls and floors of submarine canyons. With the possible exception of some banks, none of these nondepositional areas were entirely free from recent sediments, but coring and dredging operations gave the indication that the recent sediments in these places form only a thin discontinuous cover over rock or sediments of an older generation.

While basins and troughs off the southern California coast appear to be areas where deposition is important, several of these features were found to have relatively clean sand deposits underneath thin covers of mud. Since silt and clay are known to be the chief sediments contributed at the present time to the basins and troughs, the existence of this sand leads to the suspicion that even in some of these deep depressions deposition of fine grained sediment may have been inhibited in relatively recent time.

The nondepositional surfaces are found for the most part at depths too great for effective wave agitation. However, investigation of the bottom currents by R. Revelle and the speaker in all the principal environments has shown that large eddy movements are taking place with sufficient current velocity to move fine-grained sediment. These currents show no sign of decreasing velocity with increased depth. Furthermore, the discovery of relatively rapid increase in depth from time to time at the heads of submarine canyons and that these depth changes may occur during calm sea conditions suggests that mud flows or other types of submarine landslides are carrying sediments seaward. It seems probable that bottom currents and mass gravity movements are responsible for the nondepositional surfaces.

ERLING DORF: *The stratigraphic significance of the flora of the type Lance formation.*—The Lance formation at its type locality in Niobrara County, Wyo., has previously yielded a dinosaur fauna of the *Triceratops* stage, a fresh-water invertebrate fauna, and a small flora. The flora has never been described or fully studied. During the past two summers a large collection of fossil plants was obtained in this area by the speaker, under joint auspices of Carnegie Institution of Washington and Princeton University.

At present this flora comprises about 75 species, of which 8 are apparently new and 6 are not specifically determinable. More than 75 percent of the species have previously been reported elsewhere. Over 80 percent of these species occur only in formations whose Upper Cretaceous age is not in doubt: the Laramie of Colorado, the Medicine Bow of Wyoming, and the Hell Creek of Montana and the Dakotas.

Only about 10 percent of the species are known from the widespread and well-known Fort Union flora of Paleocene age. Equally distinct from the type Lance flora is the flora of the non-dinosaur-bearing beds (Tullock and Ludlow), which overlie the dinosaur-bearing beds (Hell Creek) in Montana and western Dakotas. These have previously been considered the upper part of the Lance formation. The known flora of over 50 species of the Tullock and Ludlow is clearly of Paleocene aspect, with about 85 percent of the species recorded only from the overlying Fort Union.

It is apparent that published statements that point out similarity between the Lance and Fort Union floras are erroneous and are based on inclusion in the Lance flora of species known now to have come from horizons in the Tullock or Ludlow of post-Lance age, or from beds that are actually basal Fort Union. The paleobotanical evidence indicates that the Mesozoic-Cenozoic boundary should be placed between the dinosaur-bearing beds (type Lance or Hell Creek) and the non-dinosaur-bearing beds (Tullock or Ludlow). This is in harmony with the known vertebrate evidence and does not appear to be seriously contradicted by the marine invertebrate fauna (Cannonball) associated with the Ludlow of the western Dakotas.

F. E. MATTHES: *Post-Pliocene origin of the glaciers of the Sierra Nevada.*

571ST MEETING

The 571st meeting of the Society was held in the Cosmos Club, February 8, 1939, President J. B. MERTIE, JR., presiding. The following resolution presented by J. S. WILLIAMS, seconded by J. B. REESIDE, JR., was unanimously approved by the Society:

"Mr. President: Dr. GEORGE HERBERT GIRTY, a member of this Society since January 1897, died of heart failure at his home in this city on Friday, January 27. He had recently passed his 69th birthday.

"Dr. Girty was well known to most of the members of this Society either personally or professionally as a specialist on Mississippian, Pennsylvanian, and Permian fossils. In that capacity he has cooperated, both in the laboratory and in the field, with many members in the solution of geologic problems in many States and in Alaska. The demands of his position made him spend considerable time on stratigraphic paleontology, but his greatest interest was in the field of descriptive paleontology, and he used to sit by the hour often with the bright summer sunshine streaming in through an open window, dictating descriptions of species to his stenographer. Never a showman in his professional work, many observations of great importance are rather apologetically made and obscurely placed within the texts of his descriptions of species. Many of these have been given prominence by later writers. Other observations of equal importance have never been written, because Dr. Girty belonged to the school of geological thought that believes that principles, correlations, and classifications should be based on evidence that is well in hand before they are enunciated. This fact, together with the fact that so much of his time was employed in examining and writing reports on field collections, accounts in part for the relatively small proportion of philosophical papers he published.

"Dr. Girty was author or part author of 9 professional papers and bulletins of the U. S. Geological Survey and of about 50 articles published in various journals and State survey reports. His interests were wide, and at the time of his death he had but recently completed or was working on papers describing fossils from the Mississippian, Pennsylvanian, or Permian rocks from many scattered areas extending from Pennsylvania and Ohio on the east to the Pacific Coast States on the west; and from Texas on the south to Alaska on the north. Perhaps his work best known the world over was his

Guadalupian report, which gave the first extensive description of the Permian faunas of the Southwest. Other papers, however, are known almost as widely. He has contributed through descriptive papers or reports to the knowledge of the Carboniferous geology of almost every State and territory in the United States in which Carboniferous deposits occur and also of Canada, Mexico, and countries on other continents.

"A short biographical sketch written by Dr. Girty a few years ago at the invitation of a British Journal gives many personal details of his life. In it he tells that he was born in Cleveland, Ohio, on December 30, 1869. His parents appear to have been extremely well to do, and from the beginning he lived a rather sheltered life. A great shock, which he says profoundly influenced his life, came when he was 12 years old, when his father died. He was educated in the Cleveland public schools and in Yale University, receiving his Ph.D. degree there in 1894. He came to the Geological Survey in 1895. He was very fond of music and was an accomplished pianist. In his early youth he considered selecting music as a career, but he gave it up because he felt that his talents were inadequate—"not much above mediocrity," he says. He wrote several compositions for his own pleasure—some of them during his last illness, but he published none of them. He was also fond of poetry and himself wrote poetry. When he started in his college career, he had, as he put it, "an idea" that he would like to teach Latin and Greek, both of which, especially Greek, made a strong appeal to him. His proficiency in these subjects later made him a frequent consultant of Survey members. In his senior year in college he became interested in paleontology, and this interest, as we all know, continued to be his most ardent interest until his death.

"With Dr. Girty's passing, the Society and the science of paleontology have lost an extremely able contributor, and many members of the Society have lost a sincere friend who will be sadly missed. Therefore, I move that these words of appreciation be incorporated in the minutes of this meeting and the Secretary of the Society be instructed to convey to Mrs. Girty the sincere sympathy of the membership of the Society."

Informal communications.—F. E. MATTHES described some artificial geysers near Mono Lake in California, resulting from wells.

Program.—HARRY H. HESS: *Gravity anomalies and structure of the West Indian Island arcs.*

J. C. REED: *Mineralized faults in the Chichagof mining district, Alaska.*

572D MEETING

The 572d meeting of the Society was held at the Cosmos Club, February 22, 1939, Vice-president, JOHN B. REESIDE, Jr., presiding.

Informal communications.—ROBERT P. BRYSON described some crater-shaped depressions in reservoirs, whose origin seems to be associated with gas bubbles that rise through the sediments.

Program.—E. L. STEPHENSON, *The results of magnetometer surveys on laccoliths in the Highwood Mountains, Mont.*—Magnetometer measurements were made on and near the Shonkin Sag and Cowboy Creek laccoliths in the Highwood Mountains in Montana, to trace the buried extension of a horizontal pipelike body and to locate, if possible, the feeders of the laccoliths. Approximately 2,500 readings were made with a standard Askania vertical variometer.

By means of magnetic anomalies the horizontal pipelike body was traced, with reasonable certainty, for a distance of 9,000 feet under a Tertiary gravel bench to a dikelike body exposed at the opposite side of the bench near the

Cowboy Creek laccolith. The measurements show no connection between the laccolith and these two bodies, which, therefore, are not feeders of the Cowboy Creek laccolith.

Areas of great magnetic disturbance occur over parts of each of the two laccoliths. The general form of the anomalies is that commonly associated with relatively narrow bodies of considerable vertical extent. These anomalies may indicate the presence of feeders of the laccoliths, and no other explanation seems more probable at present; however, because other conditions might produce similar anomalies, only tentative conclusions are drawn pending the completion of additional measurements.

James L. Dyson: *Structure and motion of cirque glaciers.*—Detailed study of two cirque glaciers, Sperry and Grinnell, in Glacier National Park has shown that a small cirque glacier in an extreme state of decadence exhibits its structure and other glacial phenomena very clearly. Such glaciers have motion, deposit morainic material, and perform other typical glacier functions. Sperry and Grinnell glaciers are both about the same size, each have a length of approximately one mile.

Stratification due to the annual accumulation of snow is well exhibited on these glaciers. The ice strata, each of which represents one season's snowfall, range in thickness from 2 to 6 feet and are readily apparent because their upper surfaces are covered with dust and small rock particles which make visible contact planes between each stratum. In the narrow firn zone, which lies at the base of the cirque headwall and comprises usually about 8 percent of the surface of the glacier, layers of snow are wedge- or shingle-shaped and have a steep initial tilt toward the glacier front. Weight of the overlying layers causes these wedge-shaped layers of snow to move downward and to rotate so that after traveling a relatively short distance they assume a backward dip, which gradually increases until about midway between the firn-ice boundary and the glacier front a maximum of 45° may be attained. Near the firn-ice boundary, ice strata usually are nearly horizontal or have rotated sufficiently to possess a gentle dip toward the cirque headwall. The thin part of each wedge is removed by melting, and only ice which was originally next to the headwall reaches the glacier front. On both Sperry and Grinnell glaciers the edges of ice strata are distinct enough so that between the firn area and the glacier front their number may be ascertained. Thus the approximate length of time necessary for ice at the glacier front to have moved from the cirque headwall may be determined.

In spite of the small size of these glaciers they are actively eroding the surfaces over which they move. This activity is made manifest by conspicuous amounts of rock flour in their melt waters and by abundant striae on rock surfaces from which the ice has recently retreated. The nature of many of these striae indicates that in places the ice in a very thin zone at the base of the glacier is quite plastic. Because of obstructions in the cirque floor many of the striae are extremely sinuous. Boulders were found that, after being transported in the basal portion of the glacier, were forced into crevices in the cirque floor from which the ice was unable to extricate them. Subsequently the ice was deflected around these boulders as indicated by striae that approach a boulder, curve around it, and then resume a course in direct line with their original trend.

It is suggested also that plasticity of the ice and to a lesser extent its erosive power, depend not so much upon the thickness of the ice as upon the type of internal motion it exhibits.

C. F. Brockman: *Glacial recession in Mount Rainier National Park.*

573D MEETING

The 573d meeting of the Society was held at the Cosmos Club, March 8, 1939, President J. B. MERTIE, Jr., presiding.

Informal communications.—W. W. RUBEY described the work of an advisory committee of naturalists in preserving and making accessible features of interest in the new Government park being developed along the old Chesapeake and Ohio Canal and asked members to help by drawing attention to features that they considered should be pointed out.

R. E. STEVENS presented the results of an analytical study of intergrown albite and mica from a California pegmatite, in which although the two minerals had apparently crystallized simultaneously, the mica contained 10 percent potash and only 1 percent soda, a feature that has a bearing on the existence of the soda mica paragonite.

Program.—MARGARET D. FOSTER: *Geochemical relations of ground waters in the Houston-Galveston area, Tex.*—Ground-water supplies in the Houston-Galveston area are obtained principally from permeable sands in the Willis (?), Lissie, and Beaumont formations. The shallow waters in the different formations differ characteristically in their content of calcium bicarbonate and in their total mineral content. These differences may be correlated directly with the amount and character of soluble material in the sands and clays from which the waters are derived and with the organic content of the soils through which the waters passed in entering the formation.

As they pass downward, the waters in all the formations show a progressive alteration in character, changing from calcium bicarbonate to sodium bicarbonate—a result, apparently, of reaction between the waters and base-exchange minerals in the sands. In waters in the Willis (?) sand, this alteration in type is accomplished by a continuous increase in total mineral content and in sodium bicarbonate; in the waters in the Lissie and Beaumont formations there is a gradual decrease in calcium and magnesium, accompanied by a gradual increase in sodium, the total mineral content remaining fairly constant.

The depth at which the change in character begins to take place differs in the different formations; it is greatest in the Willis (?), least in the Beaumont. Calcium chloride waters found in the vicinity of some of the salt domes may be attributed to the reverse of this softening process; deep salt water, moving upward through faults and fissures and invading the surface strata, reacts with exhausted shallow base-exchange minerals, exchanging its sodium for their calcium and magnesium. Distortion of the strata is indicated by the chemical character of some of the waters in the vicinity of Blue Ridge and Pierce Junction domes.

J. S. VHAY: *Structural features on the north side of the Beartooth Mountains near Nye, Mont.*—From a study of the geology of the Nye #2 quadrangle on the north side of the Beartooth Mountains, Mont., it is concluded (a) that relief to compression during the Laramide orogeny was localized by major zones of weakness in the basement rocks to form two zones of complex structures, and (b) that porphyry bodies along the north zone were intruded previous to the period of major deformation.

The Beartooth Mountains in the southern part of the area studied consist mainly of pre-Cambrian rocks. Along the approximately east-west trending front are steeply dipping Paleozoic, Triassic, and Jurassic formations, similar to those found elsewhere in southern Montana. In the western part of the area the mountains swing to the north and are made up for the most part of Paleozoic rocks intruded by numerous porphyry masses. The central and eastern part of the area consists of the rather broad valley bottoms of the Stillwater River and its tributaries and intervening terraces and rolling, moderately dissected pediments; it is underlain by Upper Cretaceous formations. To the northeast is an upland of considerably greater relief developed on the pyroclastic Livingston formation.

Regional structural studies have shown that the Beartooth block overthrusts in an easterly direction east of the Nye area, whereas low-angle underthrusting toward the northeast occurs west of this area.

Within the Nye area two zones of complex structures are found. The south zone coincides approximately with the mountain front but passes back into the pre-Cambrian to the west. It trends about N. 80° W. and consists of nearly parallel east-west faults arranged en echelon and dipping steeply south; movement on the faults has been mostly eastward and probably somewhat upward on the south side. The Paleozoic rocks within the fault zone stand at high angles and in places are overturned and cut by subsidiary faults; at the mouth of the Stillwater Canyon they are piled up in a schuppenlike structure north of the main fault.

The northern structural zone is on the line of the Nye-Bowler lineament. In the east half of the area it is characterized by a rather sharp anticlinal structure broken by many small en echelon faults, believed to have resulted from a dominantly horizontal movement along the zone, the south side moving eastward. Farther west along this zone are a number of porphyry intrusives, generally laccolithic in structure. Limestone Butte shows a ring fault offset by radial faults, within which the Paleozoic formations have been pushed up asymmetrically, so that the greatest displacement is on the south side, where Ordovician is against Jurassic, and porphyry masses occur along and on both sides of the fault. Round Mountain is a complex laccolith intruding a syncline, and the elongated dome to the north shows a partly concordant porphyry mass in the nose and northeast flank. Farther west, in Meyers Canyon and its north fork, compound porphyry intrusions have domed up the Lower Paleozoic rocks. The synclines around these domes associated with the porphyry are tightly compressed and in places overthrust by the domes.

Between these two zones in the central and eastern part of the area there is a shallow syncline having sharply upturned edges. Farther west the rocks dip rather uniformly northeast, except near the edge of the quadrangle where they are folded asymmetrically, the axial planes dipping northeast; the folds are cut by a few thrust faults dipping in the same direction.

It is believed that two major zones of weakness, trending about N. 80° W., existed in the basement rock previous to the Laramide deformation. In an early stage of the orogeny porphyritic magmas intruded the sediments along the north zone, and perhaps the eastern part of the Beartooth block was bowed up relative to the western part and to the surrounding plains area. During the period of major compression the Beartooth block was pushed toward the ENE. relative to the plains area to the north, so that transverse movement took place on the east-west en echelon faults of the south zone where the Beartooth block stood high, and low angle underthrusting toward the northeast occurred farther west where it stood relatively lower and was opposite the area intruded by porphyry. On the north zone deepseated movement was mainly horizontal, and the individual porphyry masses compressed and overthrust the surrounding synclines.

T. A. Hendricks: *Structural interpretation of recent gravity observations in southeastern Oklahoma.*

574TH MEETING

The 574th meeting was held at the Cosmos Club, March 22, 1939, President **John B. Mertie**, Jr., presiding.

Informal communications.—W. H. **Monroe** described a cave in sandstone that had been formed by animals licking away the rock to obtain the small amount of salt in the rock.

Program.—J. F. **Bell**: *The mechanical deformation of crystals and its relation to structural geology.*

W. H. **Bradley**: *Fossil fish of the Green River formation.*

S. R. **Capps**: *Some Pleistocene placers in Idaho.*

575TH MEETING

The 575th meeting of the Society was held at the Cosmos Club, April 12, 1939, President J. B. **Mertie**, Jr., presiding.

Program.—W. F. **Foshag**: *Problems in the study of meteorites.*

Louis S. Gardner: *Displacement along the Hurricane fault in Utah and Arizona.*—The Hurricane fault extends north and south for at least 160 miles in southwestern Utah and northwestern Arizona. At some places it is a single normal fault, but elsewhere it consists of a zone of several closely packed faults showing three periods of movement in Tertiary and Quaternary times. The faults occur at the base of a high, almost unbroken, west-facing escarpment, which is a fault scarp for 30 miles in Utah, but is a fault-line scarp near Mount Trumbull, Ariz. The stratigraphic displacement increases northward from 1,500 feet at the Colorado River to about 10,000 feet near the Pine Valley Mountains in Utah.

At many places 500 to 3,000 feet of the displacement is due to strata of the dropped block bending downward toward the fault. In a distance of half a mile or more the easterly dip increases progressively from less than 5° to more than 25° at the fault. In the raised block to the east the strata are again essentially horizontal. Farther to the east, such faults as the Sevier and West Kaibab also show this feature.

Dutton and others interpreted the structures as representing monoclines that were later cut by great normal faults. This explanation is unsuited to the Hurricane fault zone because the bending, first, is not like that in ordinary monoclines; second, is strictly confined to one side of the fault; third, is closely associated with the fault and apparently dependent upon it; and fourth, it has resulted from repeated movements, the latest of which affected a land surface that is still in existence. Explanations such as drag along the fault, or simple rotation of the dropped block, are also inconsistent with field evidence.

The bending seems to have resulted from a mobile western block sagging irregularly downward away from a stable eastern block. Evidences for this are: (1) The physiographic contrast between the structural valley of Ash Creek immediately west of the fault and the complexly eroded valley of La Verkin Creek nearby to the east; (2) recent headward erosion of Ash Creek tributaries into Great Basin alluvium; and (3) the anomolous arrangement of ridges and valleys that would exist if the land surface deformed by the last down-flexing were restored to its original condition.

J. B. **Mertie**, Jr.: *Stratigraphic measurements in parallel folds.*—Two topics are treated in this paper. The first is concerned with the development of methods for analyzing the form and curvature of parallel folds, utilizing actual field data. The second is a presentation of empirical methods for the measurement of stratigraphic dimensions in parallel folds.

The greatest desideratum of structural geologists is a better understanding of the mechanics of folding. For this objective two principal sets of data are available; first, the strength of the materials composing rocks, and second, their observed deformation. While assumptions must still be made regarding the behavior of deeply buried rocks when subjected to stress, it is nevertheless true that greater progress might be made in the study of folded rocks if all the available data could be treated quantitatively. The methods given in the first part of this paper should be useful in analyzing the geometrical forms of parallel folds.

Folded rocks having bedding surfaces which are approximately parallel are said to lie in parallel folds. Utilizing the geometrical idea of an evolute and its involutes, the author offers a more precise two-dimensional definition of parallel folds, and at the same time points out inconsistencies in earlier concepts. Suggestions are also made regarding a three-dimensional classification of parallel folds, and particular attention is directed to the similarity between Appalachian folding and certain three-dimensional graphs of the Bessel function $J_p(x)$, of the real variables p and x

It is shown that a family of involutes may be regarded as the traces of a set of stratigraphic surfaces, in a plane normal to the axis of an elongate parallel fold; and that comparable planes and involutes may exist for quaquaversal folds. Methods are presented for deriving the differential equation of the normals to a family of involutes, and for obtaining therefrom the differential equation of the involutes. The derivation of the equation of the corresponding evolute is also given. All these equations are obtained from the relationship $\delta = f(x)$, where x represents the varying distances along a geological traverse normal to the strike of the rocks, and δ represents the dip of the rocks corresponding to various values of x. The relationship $\delta = kx$, which is often assumed by geologists in the measurement of stratigraphic thickness, is utilized to exemplify the principle involved in this analysis; and the type of fold which must exist under this assumption is deduced. Geometric methods are also given for accomplishing the same results that are obtained by mathematical analysis.

The second part of the paper deals with the application of mean trigonometric functions in the determination of stratigraphic thickness and other stratigraphic dimensions. In such applications the most general case is assumed, namely, that both the strike and dip of the rocks change from point to point. Where it is possible to obtain a number of observations lying along a straight line of traverse, it is shown that the best possible results will be obtained by deriving the mean trigonometric functions corresponding to these strikes and dips, and by substituting such mean values in homoclinal formulae. This is essentially the method earlier proposed by E. L. Ickes. Where sets of observations lying upon a straight line cannot be obtained, or where for other reasons it is desirable to consider observations in pairs, different methods should be used. One such method is based upon the assumption that $\delta = kx$. Another method, proposed by the author, is developed under the empirical assumption that the traces of parallel stratigraphic surfaces in a plane, normal to such surfaces, may be considered, over short distances, to have the curvature of concentric circular arcs. Under this assumption it is found that $\delta = \arc\tan(kx+g)$ where k and g are constants, depending upon the initial and terminal values of the strike and dip. The corresponding mean trigonometric formations are then found to be the following:

$$\overline{\tan\delta} = \int_0^1 (kx+g)\,dx = \frac{k}{2} + g$$

$$\overline{\sin\delta} = \int_0^1 \sin\,[\arc\tan\,(kx+g)] = \frac{1}{k}\,(\sec\delta_2 - \sec\delta_1)$$

$$\overline{\cos\delta} = \int_0^1 \cos\,[\arc\tan\,(kx+g)] = \frac{1}{k}\log\left[\frac{\tan\delta_2+\sec\delta_2}{\tan\delta_1+\sec\delta_1}\right].$$

For purposes of rapid computation, the logarithms of $\overline{\sin\delta}$, $\overline{\cos\delta}$, and $\overline{\tan\delta}$ have been computed, with an increment of five degrees for the variable, which may be either the strike or the dip. These logarithms are utilized in substituting such mean trigonometric functions in homoclinal formulae.

576TH MEETING

The 576th meeting of the Society was held at the Cosmos Club, April 26, 1939, President J. B. MERTIE, Jr., presiding.

Informal communications.—J. J. FAHEY described peculiar crystals of dolomite embedded in gypsum, which have an octahedral form that simulates the pattern of the isometric octahedron, but the angle between the face and base is 75.5° instead of 70.5° in the octahedron. The crystals actually are the steep-sided rhombohedron, $40\bar{4}1$.

H. D. MISER described two thin dolomite layers in the Whitehorse formation in southwest Oklahoma, which, though less than half an inch thick, can be traced over an area of several hundred square miles and form good horizon markers for correlation.

Program.—DAVID GRIGGS: *Convection currents and mountain-building.*—A review of the known forces available for deformation of the earth's crust shows that only those of thermal contraction and subcrustal convection are sufficient in magnitude. Thermal contraction seems unable to supply the amount of contraction required by geologic analysis of the Tertiary mountain system. Mathematical analysis of convection by Vening Meinesz, Pekeris, and Hales indicates that subcrustal convection is probable, and would supply force of the proper magnitude. This paper presents an analysis of the convective movements which suggests that such currents would be periodic, and discusses the implications of this in mountain-building.

A convection-current cycle is suggested which may be correlated with the mountain-building cycle. To study the action of the currents on the crust, a model has been designed to be dimensionally similar to the conditions in the earth's outer shells, and to reproduce in one minute a process which takes a million years in the earth. Moving pictures of this model in action suggest a similarity between the structures so produced and those that are observed in mountains.

C. K. LEITH: *Present state of some international mineral problems.*

577TH MEETING

The 577th meeting of the Society was held at the Cosmos Club, November 8, 1939, President J. B. MERTIE, Jr., presiding.

The following resolution presented by Miss JULIA GARDNER was unanimously adopted by the Society:

"WENDELL CLAY MANSFIELD was born on June 9, 1874, in Charlotte Center in western New York, a little south of Lake Erie and east of Lake

Chautauqua. His A.B. degree was received from Syracuse University in 1908. For the two years following his graduation he taught science in the secondary schools. On June 20, 1910, he entered the Federal service as preparator to Dr. William Healey Dall, replacing the veteran collector Frank Burns. Mr. Mansfield advanced through the usual stages to the rank of geologist and in the meantime had in 1913 received a M.S. degree from George Washington University and in 1927 his doctorate. He was a member of the Geological and Biological Societies of Washington, the Paleontological Society, the Washington Academy of Sciences, and the Geological Society of America. His wife Katherine Gibson Mansfield died several years ago after a long illness, and there were no children. He accepted without bitterness, but with full realization, the comparative loneliness of his later life. He himself was in wretched health for a number of years, but there was no word of complaint or of morbid reflection. He was spared, however, a long dependence that would have been harder than physical pain, for the end came suddenly on July 24, his first day of absence from his office desk. Two sisters, a brother, and two nephews, whom he regarded with pride and affection, survive him.

"Trained under the aegis of Dr. Dall, his natural regard and respect for books and museum collections was deepened and strengthened, and the Tertiary molluscan collections at the United States National Museum bear the imprint of his care. His faunal and stratigraphic studies were focused on the middle and later Tertiary and Pleistocene of the Atlantic seaboard from Virginia to Florida. To those familiar with the deliberation with which he worked, the sum total of his published writings is surprisingly large, and most of his papers include a distinct stratigraphic contribution. He was the first to extend the Yorktown formation inland to Petersburg, Va. The description of the upper Miocene faunas of Florida—those of the Choctawhatchee formation—and their careful zoning are perhaps his most comprehensive works. In this he established the upper faunal and stratigraphic limit of the Miocene, while his work upon the Tampa had greatly aided in fixing the lower limit of the Miocene. His study of the controversial faunal and field relations of the Chickasawhay, on which he was engaged for some months before his death, was sufficiently far advanced so that it can be published in part.

"Possibly the foremost quality of the man and of his work may be indicated by the outmoded word *integrity*. Too little self-assertive and too little self-confident to be sure of the rightness of his own opinions, he was yet tenacious of a belief that he had well considered and made his own. He was never too busy to be approached and gave generously of all that was his, whether material or immaterial. He asked little of life during the later years, and those of us accustomed to the simple tenor of his ways were surprised at the diversity of interests and organizations represented in the chapel filled by those who gathered to pay the final tribute.

"Mr. President, I move that these words of appreciation be incorporated in the minutes of the Society and a copy of this statement be sent to his sister in New Jersey."

The following resolution, presented by W. C. ALDEN, was unanimously adopted by the Society:

"ARTHUR JAMES COLLIER, a member of the Geological Society of Washington, died at Coronado, Calif., on October 13, 1939. Mr. Collier was a member of the United States Geological Survey from 1896 until the time of his retirement in 1935. He was born in Wheaton, Ill., on January 5, 1866.

After moving to the West he attended the University of Oregon, and from this school he received the degrees A.B. and A.M. In 1894, Harvard University conferred on him the degree of Bachelor of Science in consequence of studies there. During the years 1910 to 1914 he served as professor of geology at the University of Oregon.

"Field studies for the Federal Geological Survey resulted in the publication of several papers, by 1908, on gold, tin, and coal deposits of Alaska. Following these came field mapping and published papers on coal and ore deposits in Oregon, Washington, and Idaho. Several years were devoted to mapping and study of the areal geology and structure of the rock formations in several districts in Montana, including coalfields, the Kevin-Sunburst oilfield, the Little Rocky Mountains, Bowdoin dome, and other possible reservoirs of oil and gas. Several papers were issued by the Geological Survey based in these studies, including also oilfields in Wyoming and the Nesson anticline in North Dakota.

"Mr. President, I move that a copy of this statement be incorporated in the minutes and that appropriate words of sympathy be sent to Mrs. Collier."

Program.—K. J. MURATA: *Volcanic ash as a source of silica for the silicification of wood.*—The chemical and physical properties of volcanic ash make it a rich source of readily available silica for geochemical processes. In recent years more and more sedimentary formations are being recognised as containing volcanic ash or its decomposition products. The common association of silicified wood with volcanic ash is noted in a list of occurrences of silicified wood in the United States, and this association is viewed as the result of a genetic relationship arising from the alterability of the ash. Silicified wood may serve as an indicator for volcanic material in sedimentary deposits.

W. D. COLLINS: *Water analyses.*—At one time the main use of water analyses was as a help in judging whether waters were safe to drink. There are still a good many who have no other thought about water analysis. The water analyses made by the Geological Survey have very little value in connection with questions relating to health. The analyses generally show the quantities of a larger or smaller number of dissolved mineral constituents, depending on the use that is to be made of the results. Analyses may be faulty, valueless, or misleading because the samples were not collected properly, because they changed in composition between the time of collection and the time of analysis, or because of errors in the analysis.

It is not easy to obtain samples that are truly representative of the sources from which they are taken. Samples collected in the course of drilling a well may represent water added in drilling rather than water present in the formations reached by the drill. Most surface waters vary so much in composition with the seasons that care must be taken in using analyses of single samples of surface waters. It is possible to take a sample from a river that will represent the water in a particular part of the stream and fail to represent the main body of water in the stream.

There have been occasions when a sample of water has changed appreciably in composition during storage because of solution of the bottle, because of the solution of insoluble matter that was in suspension in the water when collected, or because of the deposition of material that was originally in solution. This deposited material is generally calcium carbonate or hydrated iron oxide.

The special methods and precautions necessary to obtain reliable analyses of the mineral content of natural waters are not fully appreciated by some analysts who are expert in other lines of analytical work. Not all are familiar with the various checks that can be applied to test the reliability of an analysis. The inaccuracy of many analyses can be detected by inspection, but others equally in error may appear, by every test, to be entirely reasonable and reliable.

To obtain a useful and dependable water analysis it is necessary that the sample be so collected as to be truly representative; that it be submitted for analysis unchanged, and that it be analyzed with due attention to details, with careful scrutiny and checking of the results.

Tom F. W. Barth: *Thermal activity in Iceland.*—A broad belt of geologically Recent formations traverses Iceland from southwest to northeast. It is the so-called Palagonite formation, which consists of tuffs and breccias associated with basic intrusions, moraines, boulder-clays, and glacial sediments. To this belt is confined the modern volcanicity (volcanoes and fissures such as Trölladyngja, Hekla, Katla, Laki, Vatnajökull, Askja, Krafla, etc.), as well as the *acid hot springs*, which in Iceland invariably are intimately associated with active volcanism. Indeed, acid springs seem to depend on it for their existence; they are given birth by active volcanism, they are changed by volcanic events, and they die when in any local region the volcanism abates. But this does not mean that the acid thermal activity is a modern phenomenon in Iceland. It has been inferred from certain metamorphic clay deposits that the pre-glacial volcanicity also was accompanied by hot-spring action.

The *alkaline hot springs* are geographically independent of the modern volcanism. They are found in the palagonite belt, as well as on either side of this belt, in the formation of Tertiary basalts of both East Iceland and West Iceland.

Other characteristic differences between acid springs and alkaline springs are: (1) Their relation to the surface topography: acid springs are found along tectonic lines and usually on high, dry ridges, but alkaline springs are typical for areas possessing a superior ground-water supply, and break out at the foot of long hill slopes, or in depressions in the land surface, often in river beds or in the bottom of lakes; (2) the alkaline springs are much more copious than the acid ones; (3) the temperature curve is typically different for the two kinds of springs.

Both types of springs are fed by volcanic contributions; they receive their thermal energy as well as certain chemical constituents from volcanic sources. It can be shown that the farther the volcanic emanations have to travel underground before they find egress to the surface and break out as hot springs, the more alkaline they become and the more do they become diluted by ordinary ground water (thus becoming increasingly copious).

This evolution from what in a sense may be called "primary" acid springs of insignificant water discharge to "secondary" alkaline springs of considerable discharge, is in line with, and corroborates the studies conducted by A. L. Day and E. T. Allen on the thermal activity in California and in Yellowstone National Park.

578TH MEETING

The 578th meeting of the Society was held at the Cosmos Club, November 22, 1939, President John B. Mertie, Jr., presiding.

The following resolution presented by G. F. Loughlin was unanimously adopted by the Society:

"We were very sorry, though not surprised, to learn that Dr. **Waldemar Lindgren** died on November 4, 1939, at the age of 79, after a long illness. Though not a charter member of the Geological Survey, he was identified with it and with American geology from its pioneer days. Born in Sweden and educated there and at Freiberg, Germany, he came to America in 1883, with a letter of introduction to Raphael Pumpelly, who was conducting the Northern Transcontinental Survey established by the Northern Pacific Railway. Pumpelly assigned him to assist W. M. Davis, who for years afterward used to refer to his young assistant who mounted a horse on the wrong side. This work ended in 1884 and Lindgren worked for a short time as an assayer at Helena and draftsman at Anaconda, Mont., before being appointed assistant geologist in Becker's party, which was studying quicksilver deposits in California for the U. S. Geological Survey. From then until 1912 he remained with the Survey. His ability as a mining geologist, reflected in his Survey reports and scientific papers, soon gained deserved recognition and he became generally regarded as the world's outstanding authority on the science of ore deposits.

"His broad view of the subject is reflected not only in his writings on mining districts and on processes of mineral deposition, but in the time and energy that he spent in placing on a sound basis the Survey's annual statistical reports, which from 1903 on have furnished the basis for a quantitative approach to mining geology. In 1905 he organized the small group that established the journal *Economic Geology*, which promptly became the leader in its field. Lindgren continued for several years in charge of the Metals Section of the Division of Mineral Resources, and in 1908 succeeded S. F. Emmons as chief of the Section of Metalliferous Deposits. He held both positions until 1911, when he was made Chief Geologist, succeeding C. W. Hayes.

"In 1912, with the desire to give more time to original investigations than his administrative duties on the Survey permitted, he resigned to become William Barton Rogers professor of economic geology at the Massachusetts Institute of Technology, where he had been a visiting lecturer for the three preceding years. Years later, when he received the Penrose medal in recognition of his leadership, he said that he never felt cheaper than when he handed his resignation to George O. Smith, who was then director. He had grown with the Survey, and it had been such a great part of his life for so many years that it was hard to reconcile himself to the separation. In 1913 the first edition of his book *Mineral Deposits*, an outgrowth of his lectures, was published. This book also promptly became the leader in its field. He remained at Tech until his retirement about nine years ago and continued to be an inspiration to many graduate students, and an outstanding consulting geologist.

"In 1925 he served as chairman of the Division of Geology and Geography of National Research Council and successfully laid the groundwork for the publication of the *Annotated bibliography of economic geology*, the first volume of which appeared in 1928. He supervised the first 10 volumes, his many contributions to which made interesting and spicy reading, besides showing in few words the relative value of many articles on the subject.

"The science of mineral deposits is by no means a one-man science, but, when we reflect on its growth, we find that no one so much as Lindgren has contributed to and guided its advance.

"Geology and the world has suffered an irreparable loss in his passing, but we are most grateful that he was able to round out his work so well during his long career. We regret that his period of comfortable relaxation after retirement could not have been longer and we extend our sincere sympathy to his surviving relatives and to the Massachusetts Institute of Technology where he spent the last 27 years of his life.

"Mr. President, I move that the Geological Society of Washington prepare an appropriate resolution of sympathy and send it to Dr. Lindgren's nearest relatives, particularly his niece, Helen Lindgren, who has been his close companion for many years, and to the Massachusetts Institute of Technology."

Informal communications.—J. C. REED and R. R. COATES reported on the thermal gradient in mines on Chichagof Island, Alaska, which they found to be about 1.55° F. per hundred feet. The communication was presented by Mr. COATES.

Program.—P. B. KING: *Persistent structural trends in Guadalupe Mountain region, Tex.*

FRANK NEUMANN: *Seismograph evidence of deep focus earthquakes.*

W. D. URRY: *Measurement of geologic time.*

579TH MEETING

The 579th meeting of the Society was held at the Cosmos Club, December 13, 1939, President J. B. MERTIE, Jr., presiding.

Program.—Vice-president J. T. PARDEE took the chair while President MERTIE delivered his presidential address, *Placer gold in Alaska*, which was published in this JOURNAL, Vol. 30: 93–124, Mar. 15, 1940.

47TH ANNUAL MEETING

The 47th annual meeting of the Society was held immediately following the 579th regular meeting. The reports of the secretaries, auditing committee, and treasurer were read and approved.

The Society elected the following officers for the year 1940:

President: J. T. PARDEE.

Vice-presidents: C. WYTHE COOKE and L. H. ADAMS.

Treasurer: ALICE S. ALLEN.

Secretary: R. W. BROWN.

Council: D. A. ANDREWS, EUGENE CALLAGHAN, C. B. HUNT, C. B. READ, R. E. STEVENS.

The society appointed J. B. MERTIE, Jr., as its nominee for vice-president of the Washington Academy of Sciences.

PARKER D. TRASK, *Secretary*

Obituary

DAVID MYERS MOTTIER, professor emeritus of botany at Indiana University, died at the home of his daughter in Indianapolis on March 25, 1940, after a brief illness, at the age of 75 years. Born September 4, 1864, his early years were spent near his birthplace in a Swiss settlement at Patriot, in southeastern Indiana. Following his attendance at the public schools near his home, he taught for several years in the elementary schools before entering Indiana University as a student. He received the A.B. degree from Indiana in 1891 and the A.M. in 1892.

In his student days at Indiana and the few years immediately following, while he served as instructor in botany, Mottier caught the enthusiasm of such of his instructors and colleagues as David Starr Jordan, John Merle Coulter, and Douglas H. Campbell and, as the next natural step for that time, turned to Germany for further study. His formal graduate work with Strasburger at Bonn resulted in his receiving the Ph.D. degree in 1897. He later spent some time in research at the Biological Station at Naples and at the University of Leipzig.

From the time of his first appointment at Indiana University in 1891 until his retirement in 1937 he served continuously—as instructor, associate professor, professor, and departmental head—except for two leaves for study in Europe.

The pattern of Dr. Mottier's life work took form in that bright decade between 1890 and 1900 when so much was done to clarify the cytological details of the life histories of the higher plants and animals and lay the foundation for the experimental work of the present century. At that time he was acquainted, personally or by correspondence and exchange, with many of the most active workers in his field in both Europe and America. More than two years before the announcement by others of double fertilization in angiosperms, he had made excellent microscopic preparations showing a sperm in contact with the polar nuclei, but he heeded the vigorously administered advice of Strasburger and ignored it as of no consequence. As a symbol of his excellent cytological technique, one of his slides showing this phenomenon was in good condition 30 years later, although it had many times been subjected to projection with an arc light.

His most important early work was on various problems of the cytology and embryogeny of vascular plants. Later he made significant contributions to what was known of the origin and development of chloroplasts and mitochondria. His last work dealt chiefly with the prolonged culture of the gametophytes of ferns under conditions preventing fertilization.

A keen mind, a thoroughness of application, and a master of detailed perfection made him an artist in the techniques of cytological preparation and illustration. These qualities, with his seriousness of purpose in all aspects of teaching, research, and study, and his gentlemanly old-school personal qualities, are reflected in the respect of numerous students who felt his influence.

Besides numerous research papers, he prepared in 1902, under the title *Fecundation in plants*, a résumé of what was then known of fertilization in all groups. He was also the author of an elementary text in botany and a laboratory manual.

Dr. Mottier was a fellow of the American Association for the Advancement of Science, a life member of the Botanical Society of America, a charter member, fellow, and expresident of the Indiana Academy of Science, and a member of the American Society of Naturalists, the Washington Academy of Sciences, and, at times, of several other learned and honorary societies.

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

Vol. 30 December 15, 1940 No. 12

BOTANY.—*Two new genera of Acanthaceae from Guatemala.*[1] E. C. Leonard, U. S. National Museum. (Communicated by William R. Maxon.)

In the large collection of plants procured by Paul C. Standley on the 1939 Sewell Avery Expedition of the Field Museum of Natural History to Guatemala there were a number of interesting specimens of the family Acanthaceae. Represented in this material are two new genera, which are described herewith. One of these includes a species previously placed in the genus *Drejerella.*

Averia Leonard, gen. nov.

Sect. Odontonemineae. Calyx 5-partitus, tubo brevi, segmentis angustis; corolla subregularis, tubo gracili, lobis subaequalibus, obtusis vel rotundatis; stamina 2; antherae biloculares muticae, loculis parallelis, subaequaliter affixis; capsula stipitata, parva, 2- vel 4-sperma. Herbae; spicae terminales, densae; bracteae ovatae, imbricatae.

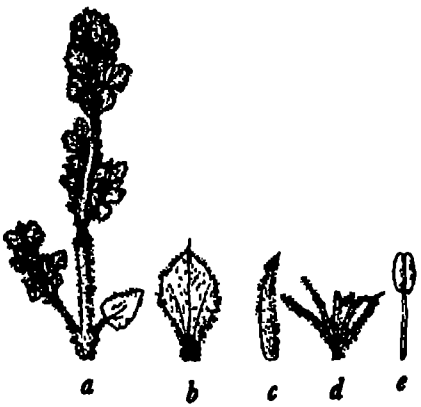

Fig. 1.—*Averia serrata* Leonard: *a*, Portion of plant, natural size; *b*, bract; *c*, bractlet; *d*, calyx; *e*, stamen. (*b*, *c*, *d*, *e*, twice natural size.)

Type species, *Drejerella longipes* Standley.

This genus is closely related to *Drejerella* Lindau, but differs in its muticous, subequal, parallel anther cells. The anther cells of *Drejerella* are subsuperposed, the lowermost strongly calcarate. In both genera the pollen grains are of the "Spangenpollen" type, with a series of longitudinal grooves and an equatorial band of pores (three).

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[1] Published by permission of the Secretary of the Smithsonian Institution. Received June 28, 1940.

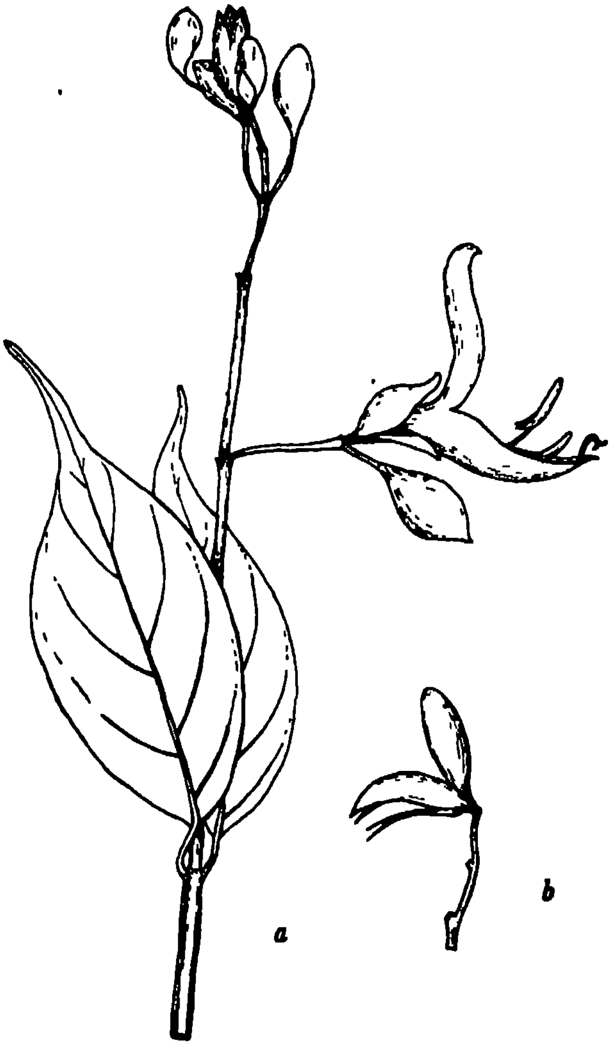

Fig. 2.—*Megalostoma viridescens* Leonard: *a*, Portion of branch; *b*, calyx (both natural size).

The name *Averia* is given in honor of Dr. Sewell Avery, director of the recent Field Museum expedition to Guatemala above mentioned.

Bracts serrate. . . . . *A. serrata*
Bracts entire. . . . . *A. longipes*

Averia serrata Leonard, sp. nov.

Herba, caulibus erectis vel adscendentibus, subteretibus, glanduloso-hirtellis; lamina foliorum ovata, apice subobtusa, apiculata, basi truncata, serrata, glanduloso-hirtella; petioli tenues; spicae multae; bracteae acutae vel obtusae, apiculatae, serratae, glanduloso-hirtellae; bracteolae lineari-lanceolatae, glanduloso-pilosae; calycis segmenta lanceolata, glanduloso-hirtella; corolla glabra, ochroleuca; capsula glabra; semina plana, muricata.

Branched herbs, suffrutescent at base; stems erect or ascending, up to 20 cm long or more, subterete, glandular-hirtellous or the older parts glabrate; leaf blades ovate, 8 mm long, 6 mm wide, obtusish and minutely apiculate at apex, truncate at base, serrate, glandular-hirtellous; petioles slender, about 5 mm long, glandular-pilose; spikes numerous, up to 2.5 cm long and 1 cm in diameter; bracts closely imbricate, rhombic, up to 5 mm long, 3 to 4.5 mm wide, acute or obtuse at apex, minutely apiculate, narrowed at base to a short petiole (2 mm long, 1 mm wide), serrate, with one to three teeth on each side, 3-nerved, glandular-hirtellous; bractlets linear-lanceolate, 6 mm long, 1 mm wide, densely glandular-pilose; calyx 5-parted, the segments lanceolate, 3.5 mm long, 0.5 mm wide, glandular-hirtellous; corolla about 8 mm long, glabrous, cream-colored, the tube 3 mm long, slender, the segments (4) obovate, subequal, 3 to 3.5 mm wide toward apex, obtuse; stamens 6 mm long, the filaments slender, glabrous, the anthers purplish; capsules clavate, 3 to 4 mm long, 2 mm broad, glabrous, 4-seeded, the seeds flat, muricate.

Type in the herbarium of the Field Museum of Natural History, no. 981916, collected at Champerico, Department Retalhuleu, Guatemala, in a dry thicket at sea level, February 26, 1939, by Paul C. Standley (no 66612). An isotype is in the U. S. National Herbarium (no. 1790340).

In general appearance *A. serrata* is similar to *A longipes*, but is readily distinguished by its serrate bracts and its smaller and more glandular leaves.

Averia longipes (Standl.) Leonard, comb. nov.

Drejerella longipes Standley, Field Mus. Publ. Bot. 8: 47. 1930.

The type, collected at Chichen Itza, Yucatan, February 27–28, 1899, by C. F. Millspaugh (no. 1621), is at the Field Museum (no. 437703), as also another specimen, collected at Buena Vista by G. F. Gaumer in 1899.

Megalostoma Leonard, gen. nov.

Sect. Louteridieae. Calyx 5-partitus, irregularis, coriaceus, segmentis lateralibus falcatis, anterioribus angustissimis; corolla bilabiata, labiis late apertis, labio superiore angusto, erecto, inferiore cochleariformi; stamina 2; antherae sagittatae. Frutex; paniculae laxae terminales.

Type species, *M. viridescens* Leonard.

The genus *Megalostoma* has apparently no close affinities, although its irregular coriaceous calyx and tubercular pollen grains suggest a possible relationship to *Louteridium* Wats. The name *Megalostoma* alludes to the widely open corollas.

Megalostoma viridescens Leonard, sp. nov.

Frutex, ramis glabris, subquadrangularibus, angulis anguste alatis; lamina foliorum oblongo-elliptica, acuminata, basi angustata, glabra; petioli tenues; paniculae laxae, secundae; calyx glaber, segmento posteriore elliptico, obtuso, lateralibus lanceolatis, subacutis, anterioribus angustissimis; corolla viridescens, glanduloso-pubescens; ovarium glabrum.

Shrub, up to 2.5 meters high; branches subquadrangular, narrowly winged, glabrous, the cystoliths subpunctiform; leaf blades oblong-elliptic, up to 12 cm long and 5 cm wide, slenderly acuminate at apex (the tip often curved), narrowed at base, glabrous, blackish in dried specimens, the cystoliths obscure; petioles slender, up to 5 mm long; flowers relatively few, secund, borne in loose terminal panicles; bracts leaflike, soon deciduous; calyx segments 1.5 cm long, the posterior segment elliptic, 7 mm wide, obtuse, the lateral pair lanceolate, 5 mm wide, acutish, falcate, the anterior pair narrowly lanceolate, 1.5 mm wide, all glabrous, coriaceous, blackish in dried specimens; corolla greenish white, glandular-pubescent, the lips about 2.5 cm long, entire, the upper lip linear-oblong, about 5 mm wide, obtuse, erect, the lower about 16 mm wide, obtuse, cochleariform; stamens equaling the corolla lips, the anthers 7 mm long, acute at the base, the sacs parallel; pollen grains ellipsoidal, tubercular, with an equatorial row of pores ("Stachelpollen"); style as long as the stamens, reclining in the lower lip of the corolla; ovary glabrous; capsule not seen.

Type in the herbarium of the Field Museum of Natural History, no. 990983, collected at Escoba, across the bay (west) from Puerto Barrios, Department Izabal, Guatemala, in a wet forest near sea level, May 3, 1939, by Paul C. Standley (no. 72948). Nos. 72896 and 73025 of Mr Standley's collection, with identical locality data, are the same.

Remarkable for its widely divergent corolla lobes, spreading at a right angle, which bear a fanciful resemblance to the yawning mouth of a pelican.

ENTOMOLOGY.—*The oviposition habits of the Eucharidae (Hymenoptera).*[1] CURTIS P. CLAUSEN, U. S. Bureau of Entomology and Plant Quarantine.

The Eucharidae are a family of small wasps that are parasitic upon the mature larvae and the pupae of ants. This limitation in host preferences to a single family or superfamily, whichever status is given to the group, is in sharp contrast to the wide host range of related families of the Chalcidoidea. The family is world-wide in distribution but is encountered most frequently in the Tropics. The adults are black, metallic blue, or green, often with the thorax distinctively sculptured, and many species have the scutellum variously modified, in may species it being produced into a conspicuous bifurcate process that may extend beyond the tip of the abdomen. Not only are they conspicuous and often weird in form, but the habits and relationships of these insects to their hosts are so unusual and varied as to be outstanding, even in an order in which the most diverse adaptations to the parasitic mode of life are found.

The first studies on the biology and habits of the Eucharidae were by Wheeler (1907), who found several species of *Orasema* associated with ants of the genera *Pheidole* and *Solenopsis* in Texas and Colorado. He reared several successive "broods" of *O. viridis* Ashm.[2] upon *Pheidole instabilis* Emery and described and figured the larval instars and the pupa. Oviposition was not observed nor were the eggs found, yet so certain was he that these must be placed directly upon the ant pupae that he described in some detail the manner in which the female was presumed to accomplish this act. The conclusions reached were entirely logical on the basis of what was then known regarding the habits of parasitic insects.

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[1] Received August 10, 1940.

[2] According to A. B. Gahan, the species here referred to is probably *Orasema wheeleri* Wheeler and not the true *viridis* Ashm. (See Proc. U. S. Nat. Mus. 88: 459. 1940.)

A few years later H. S. Smith (1912) presented a detailed account of the biology of *Perilampus hyalinus* Say, of the family Perilampidae, which is closely allied taxonomically to the Eucharidae. Here again the act of oviposition and the egg were not seen, but the first instar larva proved to be identical in general characters with that of *Orasema*. These planidia (*dimunitive wanderers*) differed from other known parasitic hymenopterous larvae in the possession of a fusiform body and a highly sclerotized and darkened integument. Because of the form and habits of the planidium of *Perilampus*, Smith was convinced that oviposition did not take place directly in or on the host, and he believed that the eggs were more probably deposited upon the food plant in the vicinity of a colony of hosts. In discussing Wheeler's observations on *Orasema* he pointed out the similarity in form and habits of the larvae with those of *Perilampus* and suggested the probability that oviposition takes place entirely outside the ant nest. Smith was able later (1917) to verify the leaf-ovipositing habit in *P. chrysopae* Cwfd., and this discovery served to stimulate interest in the habits of the two families.

The first discovery of the oviposition habits of a species of Eucharidae was purely accidental. During the course of a study of the insect fauna of wild cotton in Arizona, Pierce and Morrill (1914) chanced to observe two females of *Chalcura arizonensis* Cwfd. with their ovipositors inserted in apparently healthy blossom squares of this plant. Upon later examination these squares were found to contain masses of minute eggs immediately beneath the points of insertion of the ovipositors. This record was entirely overlooked by later workers, and it was not until the writer's account of the habits of (*Schizaspidia*) *Stilbula tenuicornis* (Ashm.), published in 1923, that the plant-oviposition habit became generally known. Since that time observations have been made upon the oviposition habits of 7 additional genera and 12 species occurring in various parts of the world,[3] and several other investigators have added to our knowledge of this subject, so that it is now possible to present an account of several of the principal oviposition habits of the family. In every instance it has been found that the eggs are deposited entirely apart from the host, that the association with plants for this purpose is obligatory, and that a wide range exists with respect to the manner of deposition of the eggs and the part of the plant on or in which they are placed.

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[3] The writer is indebted to A. B. Gahan, of the U. S. Bureau of Entomology and Plant Quarantine, for the determination of species and for the descriptions of those that have proved to be new (Proc. U. S. Nat. Mus. 88: 425–458. 1940). In a forthcoming publication (*Entomophagous insects*, New York) a short account is given of the biology and habits of the family. At the time of submission of the manuscript the names of

As an aid to others who may be interested in studying the habits of the family, it may be mentioned that the oviposition habits can be readily and quickly determined by observations on females in the field. They oviposit almost immediately after leaving the ant nest and, because of their limited and relatively slow flight, can be followed until they alight upon the plant that is to receive their eggs. The elapsed time from emergence to oviposition is usually less than 1 hour. Botanical gardens provide exceptional opportunites for the study of the Eucharidae, as the variety of plants grown there insures that some will be present that are suitable for oviposition by such species as may occur in that locality. Also, the ant population is usually relatively high and of many species. The Botanical Garden at Peradeniya, Ceylon, was especially fruitful and yielded three species in abundance during a short visit there in February 1930.

OVIPOSITION PLANTS

In Table 1 are given the species of which the habits are known and the plant or plants with which each one is associated for oviposition. The records are based on the author's observations unless otherwise indicated.

PART OF PLANT UTILIZED FOR OVIPOSITION

The part of the plant utilized for oviposition varies with the species and may be the overwintering buds, opening flower buds, stems of blossom clusters, seed pods, or leaves. The variations in habit, in relation to the part of the plant that serves to receive the eggs, are here discussed under the following headings:

1. In overwintering buds. The single species that is definitely known to pass the winter in the egg stage is *Stilbula tenuicornis* of Japan and Chosen, which places its eggs in the overwintering buds of mulberry (Fig. 1) and, to a lesser extent, in those of chestnut, oak, birch, and

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Gahan's new species were not available, and several were referred to under the generic name only. These are now assigned as follows: *Psilogaster* sp. from Malaya = *P. antennatus* Gahan; *Parapsilogaster* sp. from Ceylon = *P. laeviceps* Gahan; *Eucharis* sp. from Chosen = *E. scutellaris* Gahan; and *Schizaspidia* sp. from Malaya = *S. antennata* Gahan.

TABLE 1.—OVIPOSITION PLANTS OF THE EUCHARIDAE

Species	Plant	State or Country	Authority
Chalcura arizonensis Cwfd.	*Thurberia thespesioides.*	Arizona	Pierce & Morrill, 1914.
Chalcura deprivata (Walk.)	*Artocarpus integrifolia, Codiaeum, Cordia myxa.*	Ceylon	
Eucharis scutellaris Gahan	*Cebatha orbiculata.*	Do.	
Kapala foveatella Gir.	*Gliricidia sepium,*	Philippine Islands	Ishii, 1932.
	Leucaena glauca.	Java	
Kapala furcata (F.)	*Mikania micrantha*, a species of the Amaranthaceae	Panama	
Kapala terminalis Ashm.	*Tragia volubilis, Casearia spinescens*	Cuba	
Kapala sp.	*Tragia volubilis.*	Do.	
Losbanos uichancoi Ishii	*Celtis philippinensis, Leucaena glauca.*	Philippine Islands	Ishii, 1932.
Orasema aenea Gahan	*Ilex paraguayensis.*	Argentina	A.A. Ogloblin (Gahan, 1940).
Orasema coloradensis Wheeler	*Stylosanthes biflora, Ceanothus americanus.*	Virginia	
Orasema smithi How	*Casearia spinescens.*	Cuba	
Parapsilogaster laeviceps Gahan	*Artocarpus integrifolia.*	Ceylon	
Parapsilogaster montanus Gir.	*Sandricum koetjape, Premna* sp.	Philippine Islands	Ishii, 1932.
Psilogaster antennatus Gahan	*Mangifera indica, Erythrina* sp.	Federated Malay States	
Schizaspidia antennata Gahan	*Eugenia, Medinella.*	Do.	
Schizaspidia convergens (Walk.)	*Artocarpus integrifolia*	Ceylon	
Stilbula cynipiformis Rossi	*Picris hieracioides* var. *spinulosa.*	France	Parker, 1937.
Stilbula manipurensis (Clausen)	*Flamingia latifolia*	India	
Stilbula tenuicornis (Ashm.)	*Castanea sativa,*	Japan	
	Betula sp.,	Do.	
	Morus alba	Do.	
	Cladrastis amurensis var *floribunda*	Do.	
	Quercus mongolica	Chosen	

Cladrastis amurensis var. *floribunda* (Clausen, 1923). The entire quota of eggs of the female, numbering approximately 1,000, is deposited within the interior of the bud at one insertion of the ovipositor.

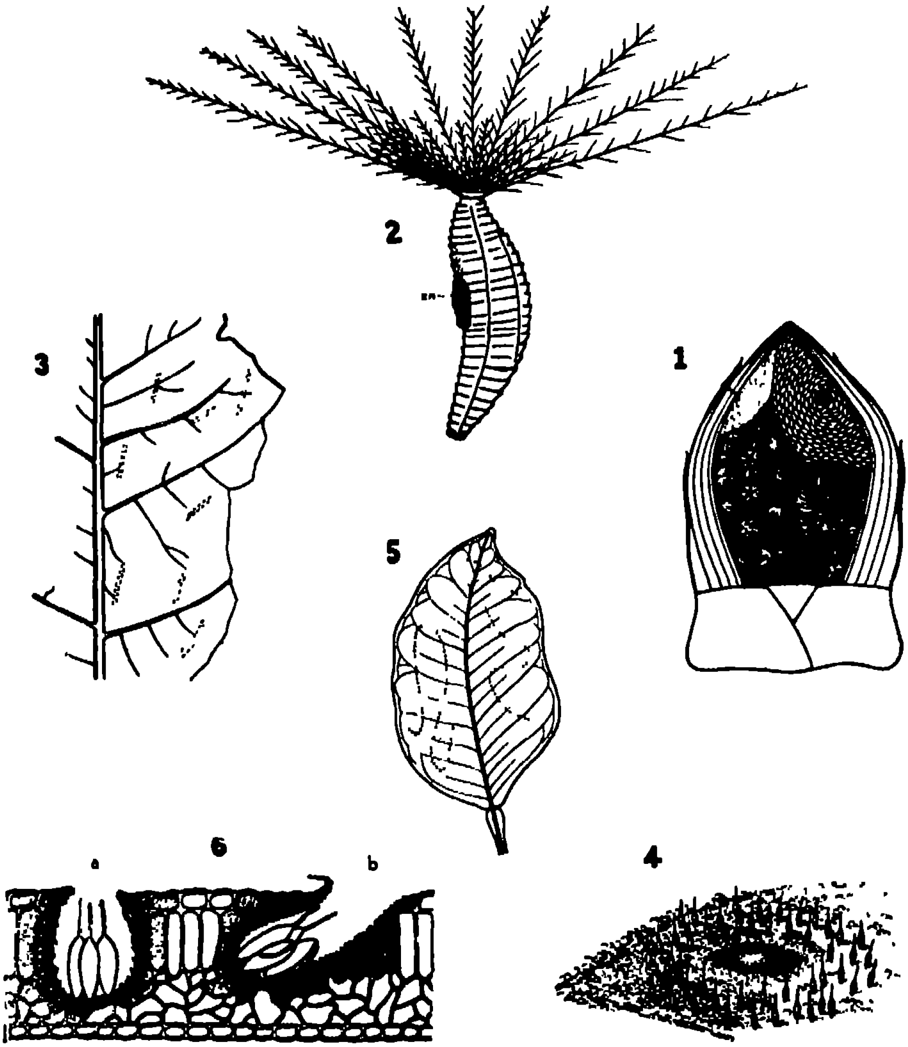

Fig. 1.—A mulberry flower bud cut away to show two egg masses of *Stilbula tenuicornis* (Ashm.). Fig. 2.—A seed, with fully expanded plumes, of *Picris hieracioides* var. *spinulosa* bearing a mass of eggs (*E.M.*) of *Stilbula cyniformis* Rossi (from Parker, 1937). Fig. 3.—A portion of a leaf showing, on its under side, the paired rows of oviposition scars of *Loebanos uichancoi* Ishii (from Ishii, 1932). Fig. 4.—A group of eggs of *Psilogaster antennatus* Gahan upon the leaf surface surrounding a freshly deposited egg of *Selenothrips rubrocinctus*. Fig. 5.—A fleshy leaf showing the serpentine lines of oviposition scars of *Schizaspidia antennata* Gahan. Fig. 6.—A diagrammatic section through a fleshy leaf showing (*a*) a group of three eggs of *Parapsilogaster laeviceps* Gahan and (*b*) a group of four eggs of *Schizaspidia antennata* Gahan in their characteristic position resulting from the insertion of the curved ovipositor at a sharp angle to the leaf surface.

These eggs remain therein until the following spring, when the buds expand and the great majority of egg masses fall to the ground with the bud scales. A portion of the buds die, however, and the scales draw apart somewhat, thus permitting the escape of the larvae, which hatch from the eggs during July and early in August.

2. In expanding leaf and flower buds. A number of species, representing several genera, utilize the expanding leaf and flower buds of various plants for oviposition. *Eucharis scutellaris* of Chosen, which oviposits in those of a trailing vine of the genus *Cebatha*, may even deposit her eggs in fully opened blossoms. Less than 50 eggs are placed in the center of each one, and consequently each female visits a considerable number of blossoms before oviposition is complete. *Kapala furcata* oviposits similarly in the flower buds of another vine, of the genus *Mikania*, and of an undetermined species of Amaranthaceae. A colony of this parasite was found inhabiting the small plot of open ground immediately in front of the main laboratory building on Barro Colorado Island, Panama Canal Zone.

Chalcura arizonensis deposits its eggs in the blossoms of wild cotton in Arizona, while *C. deprivata* of Ceylon does so in the leaf buds of jak fruit, though some individuals were seen to utilize the expanding flower buds of croton and *Cordia*. *Stilbula manipurensis* of Assam places its eggs in masses beneath one of the outer scales of the large, loosely formed buds of *Flamingia* (Clausen, 1928). *Schizaspidia convergens* deposits them in clusters of a few hundred beneath the outer scales of leaf buds, and occasionally in the flower buds also, of jak fruit in Ceylon, and usually high up in the tree. Buds containing egg masses can frequently be recognized by the presence of a curled ribbon or thread of white congealed sap, several millimeters in length, at the point penetrated by the ovipositor. In all these species the incubation period is relatively short, covering not more than two weeks, but before hatching takes place the bud scales and petals fall to the ground and carry the great majority of eggs with them.

3. In seed receptacles. Parker (1937) describes the oviposition of *Stilbula cyniformis* in the seed heads of a small composite plant of the genus *Picris* in southern France. The eggs are deposited en masse among the bracts or adhering to the outer layer of seeds. As the seed head opens the plumes of each seed expand and the seed, with its burden of eggs (Fig. 2), is blown away. Inasmuch as oviposition takes place only during August, it is possible that this species, like *S. tenuicornis*, passes the winter in the egg stage. After completion of oviposition the female often dies with her ovipositor still inserted in the seed receptacle.

4. In incisions in leaf tissue. The females of *Schizaspidia antennata*, the commonest of the eucharid species observed at Kuala Lumpur, Federated Malay States, usually deposit their eggs in pairs, but at times in groups of three or four, in incisions in the under sides of the fleshy leaves of *Eugenia*, *Medinella*, etc. These punctures are evenly spaced about 1 millimeter apart and are made in serpentine rows over the leaf (Figs. 5, 6, *b*). When the trees are in bloom oviposition is frequently in the fleshy stems of the blossom clusters rather than in the leaves. *Parapsilogaster laeviceps* shows a pronounced preference for the half-grown leaves of jak fruit, the eggs are laid singly in incisions on the under side, usually near the leaf margin, and the incisions are made somewhat at random rather than in rows.

In July 1932 J. C. Bridwell showed the writer a colony of *Orasema coloradensis* at Barcroft, Va., that was restricted to a very limited area along a railroad right-of-way and bordering a wooded area. The females were seen to be ovipositing in the younger leaves of the small-leaf pencil-flower, *Stylosanthes biflora*, and also occasionally beneath the bud scales of the large-leaf Jersey tea, *Ceanothus americanus* (determinations by Dr. S. F. Blake). In the pencil-flower the eggs are placed singly or in pairs in incisions in the under sides of the younger leaves. between the parallel veins. While there may be several punctures in a row, yet because of the small size of the leaf any distinct linear or serpentine arrangement of the punctures is prevented. An elongate area of leaf-tissue about the puncture becomes discolored and dies. In the limited area inhabited by this colony practically every leaf of the pencil-flower contained one or more eggs, and the numerous areas of dead tissue gave the plants the appearance of being diseased. *O. smithi* oviposits in the same way, but this species is distinctive in that it oviposits only in the upper sides of the leaves and limits itself to those within 2 feet of the ground. *Kapala terminalis* likewise oviposits in the upper rather than the lower sides of the leaves.

Ishii (1932) describes the somewhat similar leaf-ovipositing habits of two species from the Philippine Islands. The females of *Kapala foveatella* place one to four eggs in each incision in the lower sides of the leaves of *Gliricidia and Leucaena*. The oviposition punctures made by *Losbanos uichancoi* on the under sides of the leaves of *Celtis* and *Leucaena* occur in two short parallel rows, each row comprising five to ten punctures. This oviposition in a double rather than in a single row, as is the habit of other species, is an interesting variation, but unfortunately the author does not describe the manner in which it is accomplished. His illustration (Fig. 3) indicates that the two rows of eggs are deposited simultaneously, the ovipositor apparently being inserted alternately right and left as the female moves forward.

5. At random on leaf surface. This oviposition habit was first observed by Ishii in the case of *Parapsilogaster montanus* at Los Banos, Philippine Islands. The eggs are deposited horizontally on the under sides of the leaves of *Sandricum* and *Premna*, and, when abundant, they give a white, powdery appearance to the leaf surface. A species of *Kapala* found in Cuba, and not distinguishable in the adult stage from *K. terminalis*, oviposits in the same way upon the leaves of *Tragia volubilis*. A female normally deposits her entire quota of eggs upon a single leaf, and each of these may bear many thousands of eggs. She walks about very slowly over the leaf, tapping its surface rapidly with the tip of the ovipositor, and one or two eggs are extruded each time. Leaves bearing fully incubated eggs appear as if covered with a fungous growth, the slender egg stalks resembling hyphae and the deep amber-colored egg bodies the conidia. These species, and *Psilogaster antennatus*, are among the very few Chalcidoidea that deposit eggs of the stalked type in such a position that they are completely exposed.

6. Upon leaf surface associated with thrips eggs. One of the most striking and highly specialized adaptations in oviposition in the Eucharidae was observed in the Malayan *Psilogaster antennatus*, which was collected in some numbers in January 1930 near Kuala Lampur. The eggs are placed vertically, regularly spaced and in numbers up to 100, in the immediate vicinity of a freshly deposited thrips egg (Fig. 4). Under cage conditions oviposition could not be secured in the absence of these eggs, and the relationship appears to be obligatory. The thrips species concerned, *Selenothrips rubrocinctus* (Giard), was found commonly only on mango and *Erythrina* foliage. The thrips female partially inserts the egg in an incision in the under side of the leaf and covers it with a mass of excrement. The female parasite is attracted to the egg itself rather than to excrementous covering. The parasite's association with the foliage of the two trees mentioned is believed to be incidental and it very probably will be found to frequent any type of plant which bears an infestation of *Selenothrips*. The presumed ant host of *Psilogaster* is not known, so it is impossible to give any convincing explanation of this association with thrips. Several species of the genus have been reared from *Myrmecia* and *Pheidole*, so there is little basis for believing in any radical departure in host preferences. The association with thrips undoubtedly relates to phoresy, as the eggs hatch simultaneously with those of the carrier and the planidia attach themselves to the young thrips larva as soon as it emerges from the egg and are carried about until the first molt of the latter. Were the thrips attended by ants, or carried into their nests, the relationship would serve a definite and obvious purpose, but such is not the case.

The number of species for which information is available regarding their oviposition habits is still too small to warrant any generalizations, and in all probability other and perhaps radical departures from those discussed will be found. In examining the data given in the preceding paragraphs it is seen that there is little uniformity in habit even among species of a genus. *Parapsilogaster laeviceps* places its eggs in incisions in leaf tissue, whereas *P. montanus* deposits them at random on the leaf surface. *Kapala foveatella* and *K. terminalis* oviposit in leaf tissue, *K. furcata* in the expanding blossom buds of a vine, and an undetermined species of *Kapala* places its eggs loosely upon the leaf surface. *Stilbula tenuicornis* oviposits in overwintering leaf and flower buds, *S. manipurensis* in expanding flower buds, and *S. cyniformis* in seed receptacles. The three species of *Orasema* are, however, consistent in placing their eggs in incisions in leaves.

MANNER OF OVIPOSITION

The species of *Stilbula*, *Kapala*, *Eucharis*, *Chalcura*, and *Schizaspidia* that deposit their eggs in buds or seed receptacles have a uniform manner of oviposition. The female penetrates the scales or covering by a downward thrust of the ovipositor, and full penetration of a bud with heavy scales may require 5 minutes or more. In no instance has a female been seen to insert the ovipositor between the scales.

Two distinct methods of oviposition are found among the species that oviposit in leaf tissue. *Parapsilogaster laeviceps* (Fig. 6, *a*) and *Orasema coloradensis* merely puncture the leaf tissue by a perpendicular thrust of the straight ovipositor, and consequently the perforation in the epidermis is found at the center of an area of dead tissue, which, within a few days, becomes about 1 millimeter in diameter. *Schizaspidia antennata*, however, has a much heavier ovipositor, which is distinctly curved downward, so that when it is lowered preparatory to oviposition the tip is directed forward. Insertion into the leaf is consequently effected by a forward pull rather than by a backward or downward thrust. After being inserted to the proper depth in the fleshy leaf tissue, it is swung from side to side through an arc of about 45°, with the base held stationary. This results in the formation of a fan-shaped recess within the leaf, in which two to four eggs are placed (Fig. 6, *b*). On leaves in which eggs have been deposited several days previously the area of dead tissue is almost entirely posterior to the surface incision.

It has been mentioned that *Schizaspidia antennata* oviposits also in the heavy fleshy stems of the flower clusters of certain trees. At these times it often happens that the eggs are deposited externally rather than embedded in the stems. The tissues of the stem are very soft and tender and offer very little resistance to the ovipositor. It is inserted transversely to the axis of the stem but, because of its curvature, the tip breaks through the surface farther on, thus making a double perforation of the epidermis such as is done with a curved surgeon's needle. The eggs are then extruded from the ovipositor and only the slender anterior stalks remain embedded in the puncture.

Orasema smithi inserts the ovipositor in the same way as *Schizaspidia antennata*, and its incisions are readily recognized by the triangular form of the surface puncture. The single egg deposited at each insertion is found at the anterior end of the cavity rather than at the center.

The female of *Psilogaster antennatus* makes a very minute puncture in the epidermis of the mango leaf and embeds the pointed posterior tip of the egg therein so that it is firmly held in an erect position, with the anterior stalk turgid and straight.

The form of the incision and the cavity produced in the plant tissue are thus seen to differ among species and they permit of provisional recognition in the field. An examination of the ovipositors of the females often gives a clue to the manner and place of oviposition. A heavy curved ovipositor points to oviposition in succulent leaves and stems whereas one which is long, straight, and slender indicates that the eggs are probably placed in buds or seed pods.

SUITABILITY OF DIFFERENT PLANTS FOR OVIPOSITION

The suitability or otherwise of a plant for oviposition by Eucharidae appears to be governed mainly by the physical qualities of the part in which the eggs are placed, rather than by definite attraction. *Stilbula tenuicornis*, a bud-ovipositing species, favors mulberry in northern Japan, but it also oviposits to a lesser extent in chestnut, birch, and *Cladrastis*, while in Chosen it was seen to do so in the buds of oak. These buds have certain qualities in common. The scales, while firm, are not too hard for penetration by the ovipositor, the interior of the bud has at least a small amount of free space in which the eggs may be placed, and the sap is nonresinous. The adults of this species are present in the field for only about three weeks each year, and they consequently are limited in oviposition to such trees as have their buds fully formed at that time. The same requirements are encountered among other species, such as *S. cyniformis*, which oviposit in seed receptacles.

Among the leaf-ovipositing species, those that insert the eggs in incisions in the tissue restrict themselves to plants having leaves with certain physical qualities. When one surface is punctured the wound must remain permanently open to permit of the later escape of the larvae. This rules out the plants that exude appreciable amounts of sap from leaf wounds. Plants with rather fleshy and smooth leaves, such as *Artocarpus*, *Citrus*, and *Codiaeum*, are most frequently chosen. The two leaf-ovipositing species observed in Ceylon, representing the genera *Parapsilogaster* and *Chalcura*, both deposit the great bulk of their eggs in *Artocarpus*. *Orasema smithi* and *Kapala terminalis*, which were found in the same habitat at Hoyo Colorado, Cuba, both oviposit in the leaves of *Casearia*. *O. coloradensis*, however, chooses the small and very delicate leaves of *Stylosanthes*. The collection notes of C. F. Baker, given by Gahan in his discussion of *O. wheeleri* Wheeler, show three collections on separate dates on *Eriogonum* at Fort Collins, Colorado. It is quite possible that the females were ovipositing in the leaves of that plant.

In the temperate regions, where the various species apparently have only a single generation each year and the adults are present for only a very short period, the number of plant species that serve for oviposition is at a minimum and a single one may suffice. That chosen in one locality may differ from the one favored in another. Some of the tropical Eucharidae, most of which are assumed to have overlapping generations throughout the year, may change their oviposition plants with the seasons. This is of most probable occurrence among those that oviposit in buds, particularly flower buds, and seed receptacles.

The above generalization regarding the factors influencing the choice of plants for oviposition apparently does not hold true with species that deposit their eggs in expanding flower buds, and some, at least, exhibit a strong response to what is apparently an odor stimulus. The most striking example of such a reaction was observed in *Eucharis scutellaris*, which places its eggs in the flower buds of *Cebatha orbiculata*. A sprig of this vine held near an ant nest from which *Eucharis* is emerging will attract all females in the vicinity within a few minutes. If shaken off they immediately return to the buds and cling to them tenaciously. The males, however, are not attracted to these buds.

Only two species are known to deposit their eggs at random on the leaf surface, but in these instances the plants favored for oviposition have leaves with a hairless and glossy under surface.

RATE OF OVIPOSITION

The total egg capacity of the females of the Eucharidae ranges from a minimum of about 1,000 to a maximum of 10,000 or more. The eggs are very minute, seldom exceeding 0.2 mm in length even in the larger species, and those of the smaller species may not exceed 0.1 mm. The smaller total given above is for *Stilbula tenuicornis*, which deposits the entire lot en masse in a bud during an elapsed time averaging 20 minutes. This is at the rate of one egg a second, and consequently they must flow from the ovipositor in virtually an unbroken stream during this period. Where the parasite population is high, as in one locality near Koiwai, Japan, several of these masses are deposited in each bud, and one rather sparse mulberry bush 7 feet in height was estimated to contain 4,320,000 eggs. One bud was found to contain 24 egg masses. Because of the limited space available in the bud a high pressure must be exerted by the later females in forcing their eggs into the bud, and instances were seen where previously deposited eggs had been forced out through the older ovipositor puncture holes in the bud scales. The most striking illustration of such pressure was observed in *S. manipurensis*. One *Flamingia* bud showed a "ribbon" of eggs 2.5 mm in length and 1.0 mm in width that had been forced out from beneath the margin of a bud scale at a distance of 2 mm from the point of insertion of the ovipositor.

An undetermined species of *Kapala* from Cuba, which deposits its eggs at random on the leaf surface, has an exceedingly high egg capacity. One female deposited a total of approximately 10,000 eggs during a period of six hours. While the rapidity of deposition does not equal that of *Stilbula*, yet the total is much greater. Parker (1937) mentions the possibility of the production of 10,000 to 15,000 eggs by each female of *Stilbula cyniformis*.

In general it is the habit of the species that deposit their eggs en masse to complete oviposition the day of emergence from the host nest, and this appears to be true also of those that place them at random on the surface of leaves. Those that insert them singly or in small groups in leaf tissue are more deliberate in their oviposition activities and this may extend over one week or more. The number of eggs deposited each day is consequently only a few hundred, though a female of *Schizaspidia antennata* was seen to make 10 to 12 insertions of the ovipositor a minute, which represents a deposition of about 30 eggs during that period. In other species, however, the interval between insertions is much longer.

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ENTOMOLOGY.—*A genus of histerid beetles new to the United States.*[1] Rupert L. Wenzel, Field Museum of Natural History. (Communicated by Edward A. Chapin.)

During the summer of 1938, I had occasion to visit the U. S. National Museum and to examine briefly the Histeridae of that institution's collection. A specimen collected in Texas and determined by Herbert S. Barber as *Reninus salvini* Lewis was called to my attention. Reference to the original description of that species revealed a discrepancy between the specimen and the description; however, on the basis of notes made by Dr. Gilbert J. Arrow, of the British Museum, who kindly examined the type, there can be no doubt that the Texas example is to be referred to that name. Since the genus *Reninus* has not heretofore been known from America north of Mexico, a generic and species description are given here. Acknowledgment is due Dr. Edward A. Chapin and H. S. Barber for their kind cooperation in making the specimen available for study.

Genus **Reninus** (s. str.) Lewis

Reninus Lewis, 1889, p. 275.
Renia Lewis, 1885, p. 467.

Form oblong-oval, moderately convex. Head with a marginal carina on each side of the epistoma, the carina continuous with the supraorbital stria. Labrum transverse, its anterior margin straight or with a slight production inferiorly. Antennae with nine articles, the club consisting of a "single" article, which is strongly sclerotized at base and densely pubescent at apex;

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[1] Received July 25, 1940.

flagellum articulated laterally to the antennal scape, which is angulately swollen distally. Pronotum transverse, anterior angles obliquely truncated; marginal pronotal stria present, lateral pronotal striae absent. Elytral striae carinate. Propygidium transverse, hexagonal, nearly twice as broad as long. Pygidium subcircular, nearly vertical Prosternal keel striate, basal margin deeply, angulately incised; prosternal lobe broad. Antennal cavities deep, visible from beneath. Mesosternum very short, consisting of little more than a strongly angulate process, which fits into the incised prosternal base Tibiae rather strongly expanded; all the tarsal grooves distinct, straight, only their inner margins well defined Outer margin of anterior tibiae broadly, evenly arcuate, multidenticulate, the denticles fine, short, spinelike. Outer margin of middle and posterior tibiae more or less angulate, denticulate as in the anterior tibiae. All the tarsi of five articles, ultimate article bearing two claws

Genotype.—*Reninus meticulosus* Lewis, 1885, p. 467.

According to Reichensperger (1935, p. 26), the genus *Brachyhister* Bickhardt (1917, p 234) should be placed under *Reninus* and is not to be accorded any higher ranking than that of a subgenus. The arguments in favor of this arrangement are well founded, and it will probably be most satisfactory to follow it

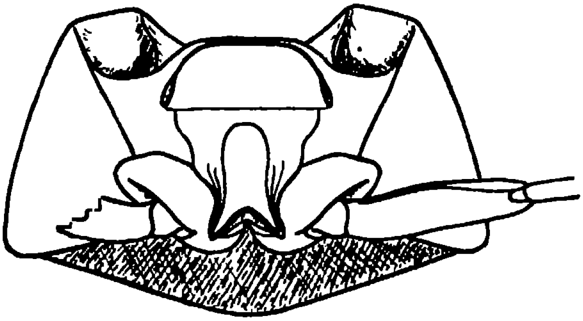

Fig 1 —*Reninus salvini* Lewis: View showing gross structure of under side of prothorax

My diagnosis of *Reninus* would undoubtedly be of more value if it were based on all the species known; however, since many of the forms are unavailable, the description is based on characters known to me, and it will serve to separate *R. salvini* from the species of other North American histerid genera.

Reninus belongs to the tribe Hetaeriomorphini of the subfamily Hetaeriinae and may be separated from the other North American genera of the tribe as follows:

1. Elytra with dorsal striae. 2
   Elytra rather densely punctate, without dorsal striae. . . .4
2. Anterior margin of mesosternum deeply emarginate to receive the prosternal base; anterior tibiae subcircular; a lateral pronotal stria present . . .. *Yarmister* Wenzel (1939, p. 391)
   Anterior margin of mesosternum produced (feebly in *Ulkeus*), the mesosternal process received in the emarginate prosternal base; anterior tibiae not subcircular, though they may be strongly expanded; pronotum without a lateral stria in addition to the marginal stria. 3

3. Pronotum without a lateral gibbous area; anterior margin of mesosternum strongly, angulately produced, the process received in the strongly emarginate prosternal base; elytra without rows of trichomes along the striae . . . . *Reninus* Lewis

   Pronotum with a longitudinal gibbous area on each side; anterior margin of mesosternum feebly, obtusely produced (nearly truncate); elytra with rows of trichomes along the striae. *Ulkeus* Horn (1885, p. 143)

4. Elytra without dorsal striae, rather densely punctate; pronotum gibbous at the sides, the gibbous area divided into distinct cushionlike lobes; anterior margin of mesosternum produced and received in the angulately emarginate prosternal base... . *Terapus* Marseul (1862, p. 680)

The tribe Hetaeriini (composed in North America of the genera *Echinodes* and *Hetaerius*) may be separated from the Hetaeriomorphini by the condition of the antennal club, which is oval in the latter tribe; in the Hetaeriini the club is cylindrical and truncated at the tip, the truncated tip being densely pubescent.

Reninus salvini (Lewis) Fig. 1

Renia salvini Lewis, 1888, p. 220, pl. 8, figs. 6, 7.
Reninus salvini Lewis, 1905, p. 52.

Form oblong-oval, moderately convex. Color deep reddish brown, shining. Head, labrum, and mandibles with fine, sparse, setigerous punctures, those of the mandibles aciculate. Mandibles and vertex of head with a few fine rugae. Supraorbital stria distinct but somewhat broken up, continuous on each side with the cariniform marginal stria which commences within the eyes and extends to the anterior margin of the epistoma.

Pronotum a little less than twice as wide as long, rather strongly impressed on each side near the anterior angles, less strongly impressed on each side near base, sharply, sparsely punctulate throughout; sides nearly straight, moderately converging to the truncated anterior angles. Marginal pronotal stria extremely fine, cariniform, complete laterally, interrupted behind the head.

Elytra sharply, sparsely punctulate throughout. Epipleura finely strigose, with two fine cariniform striae, of which the outer is short and apical, the inner (marginal elytral stria) is very close to the epipleural margin basally but extends dorsally to transverse the epipleural fossette on apical two-thirds, and from thence extends half way across the elytral apical margin. External subhumeral stria complete, cariniform, strongly sinuous, and "fused" with the internal subhumeral stria for a short distance near the middle; internal subhumeral stria complete, nearly straight, costiform basally, finely cariniform and close to the first dorsal stria near apex, forming the margin between the elytral disc and the epipleuron. First dorsal stria complete, cariniform basally, costiform apically; second dorsal stria finely cariniform, very slightly abbreviated at apex; third and fourth dorsal striae finely cariniform, extending to about apical third, the fourth stria arching broadly at base and recurving briefly along the suture; sutural stria absent; internal subhumeral stria and the dorsal striae strongly, inwardly, transversely hooked at base. Propygidium and pygidium sparsely punctulate.

Prosternum moderately broad, the keel completely margined, the carinal striae finely cariniform, joined in an arch anteriorly and continuous at base along the incised margin; lateral prosternal striae cariniform, divergent and ascending, extending to the prosternal lobe; on each side between the carinal and lateral striae are two fine abbreviated striae; prosternum (except the enclosed keel) and prosternal lobe microscopically, densely strigose and sparsely, finely punctate, the punctures elongate, linear. Prosternal lobe with the anterior margin truncate, margined, the marginal stria deep and terminating on each side in deep, elongate foveae.

Mesosternum very short, strongly, angulately produced at middle; meso-metasternal stria slightly anterior to the meso-metasternal suture, and trisinuate, the middle sinuation strongest Metasternum sparsely, remotely punctulate, with four apically diverging striae on each side, these striae joined medial to the middle coxal cavity; the innermost stria is straight and extends posteriorly one-half the length of the metasternum; the next stria is complete and extends to the anterior margin of the posterior coxal cavity; the two outer stria are arcuate and extend laterally on the elevated metasternal sides. Meso- and metathoracic pleurites with a number of strioliform punctures. Anterior margin of first abdominal sternite with a complete transverse, crenate, marginal stria; within the coxae on each side are three cariniform, longitudinal striae of varying length

Length: 3.5–4.2 mm. Width: 2.7 mm.

Remarks.—The specimen upon which this description is based was collected by E V. Walters in a nest of *Atta texana* (Buckley) at a depth of between 6 and 10 feet at San Antonio, Tex., January 17, 1935.

Lewis's type of this species was collected in an ant nest beneath a stone at Atlisca, Puebla, Mexico, but the host was not recorded. Later (1907, p. 105) Lewis recorded *Atta cephalotes* as a host species, and Bickhardt (1917, p. 241) gives *Atta fervens* Say (*sic*). Other *Reninus* are known to be attaphiles, and one species (*R. meticulosus* Lewis) has been recorded from *Atta* nests (*A. sexdens*, fide Reichensperger, loc cit) and from termite galleries (Lewis) The attaphilous Histeridae, believed to be chiefly synechthrans, are few in number, the only other species apparently known from the United States being *Acritus attaphilus* Wenzel (loc. cit , p. 384).

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ZOOLOGY.—Austrobdella anoculata, *a new species of fish leech from Greenland.*[1] J. PERCY MOORE, University of Pennsylvania. (Communicated by WALDO L. SCHMITT.)

In the course of his many expeditions to the Arctic, Capt. Robert A. Bartlett has brought back extensive collections of animal and plant life from that region. Among the material collected on opposite sides of Greenland, seven years apart, he obtained two contracted examples of a small marine leech, of which the host is unknown, one from northwest Greenland between Capes Alexander and Chalon, and the other from northeast Greenland.

I have been unable to harmonize them with the description of any species hitherto reported from our northern seas. Except for minor differences, they agree with the type of Badham's genus *Austrobdella.* Of the two, the paratype is somewhat less contracted and distorted and for that reason was sectioned for study of the internal anatomy. The drawings and description are based upon both specimens.

Austrobdella anoculata, new species Figs. 1–4

Diagnosis.—Similar to *A. translucens* Badham,[2] but distinguished by absence of eyes, abdomen less abruptly shouldered in adult, somites typically tri- (sex-) annulate; gonopores separated by two annuli, ovisacs short, without prolonged posterior lobes; last pair of gastric caeca with about one-fifth of their caudal ends disunited.

Description.—Body divided into two regions, "neck" and "abdomen," the former short and subcylindrical, the latter about three times as long, abruptly wider and moderately depressed. Measurements in millimeters of type: Length 4 6, to ♂ pore 1.0; widths, cephalic sucker (contracted) about 0.4, at ♂ pore 0.65, maximum (XIX–XX) 1.8, anus 0.7; caudal sucker 0.9; depths not measured but in neck slightly less than widths, in abdomen about three-fourths widths. Paratype at same points 6.8, 1, 4.7, 0.8, 2.1, 0.75, 1.0; maximum depth about 1 4. Cephalic sucker small, about one-half diameter of caudal sucker, normally cup-shaped, but so contracted in both specimens that ventrally it appears as a thickened annular rim surrounding a deep central depression; in dorsal aspect hemispherical, not definitely wider than the first nuchal somites, without obvious markings, only a few very faint traces of annuli on caudal part and a few scattered, very minute, sensory papillae. Eyes absent, in sections a few pigment granules near middle of head, but no pigment cups or visual cells. Mouth seen only in sections as a minute pore on the cephalic slope of a slight papilla at the center of the ventral face of the sucker. Neck sharply differentiated from abdomen (most so in paratype), subcylindrical, slightly depressed, short, about one-sixth or one-seventh length of abdomen, its maximum width about one-seventh that of the widest part of the abdomen, increasing slightly in width cephalocaudad but again slightly contracted at the clitellum; preclitellar annuli about 13, but irregular, some of them double; intermetameric furrows, including the nuchal groove,

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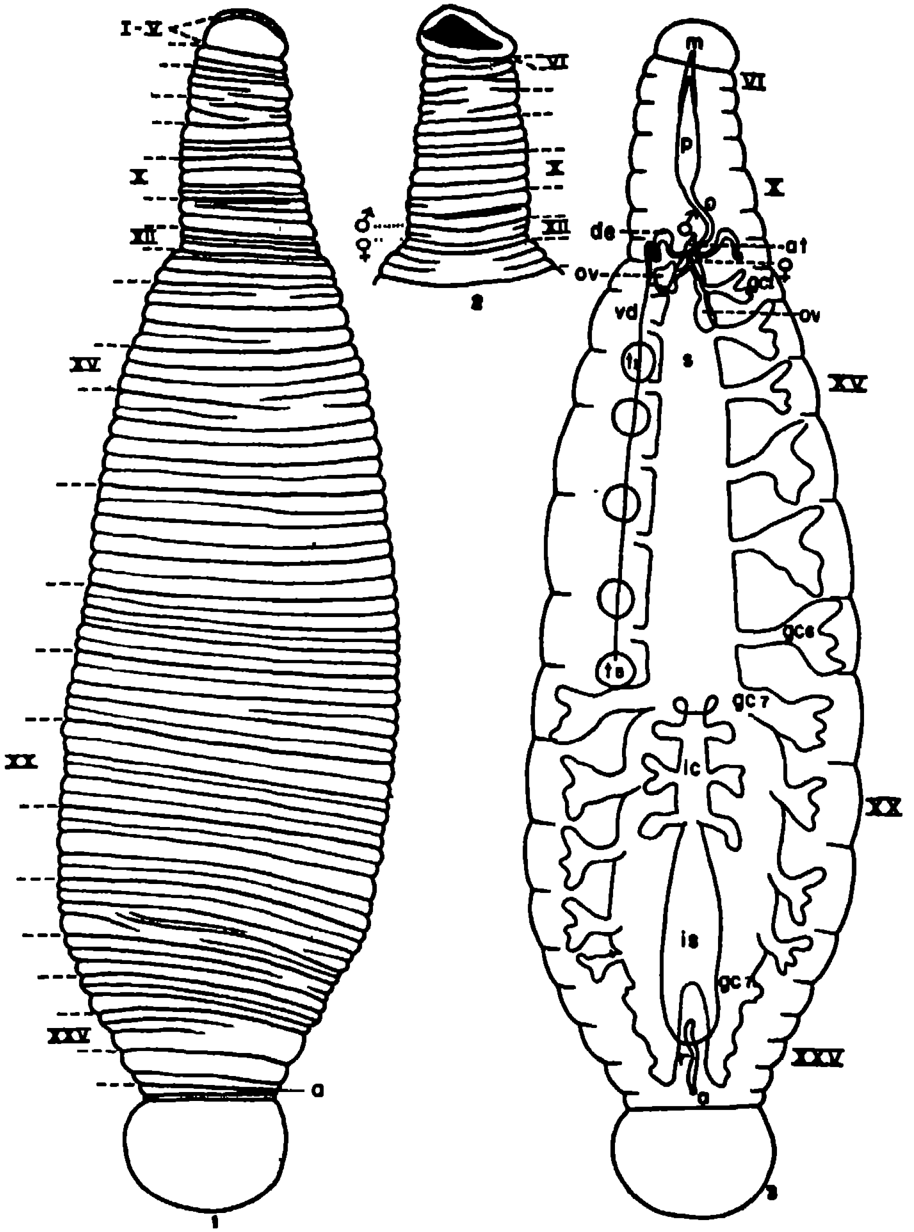
[1] Received August 6, 1940.

[2] Quart. Journ Micr. Sci. (new ser.) 62: 1. 1916.



Figs. 1–3.—*Austrobdella anoculata.* × ca 28.

1. Annulation in dorsal aspect as worked out from a comparison of the two specimens. In most respects they agree. Where they differ the one appearing most normal or clearest is usually represented, or in other cases the paratype is represented on the left, the type on the right side. Somites are numbered in Roman on left side. *a*, Anus.
2. Ventral aspect of first 13 segments showing the position of the gonopores.
3. Semidiagrammatic representation of the chief features of the digestive and reproductive organs. The gastric caeca are shown complete on the right side, the male organs on the left side only. *a*, Anus; *at*, atrium; *de*, ductus ejaculatorius; *gc 1–7*, gastric caeca; *ic*, caecate intestine; *is*, saccate intestine; *m*, mouth; *o*, esophagus; *p*, pharynx; *r*, rectum; *s*, stomach or crop; *t 1–6*, testes of left side; *vd*, vas deferens; ♂, male gonopore; ♀, female gonopore.

generally deeper than the interannular furrows and the only visible external metameric character; most somites 3-annulate. Clitellum ill-defined, somite X not modified, XI and XII somewhat narrower, about as wide as the first nuchal annulus, XII embraced at its caudal end by the anterior fold of the wider first abdominal annulus, into which it is slightly recessed; somites XI and XII triannulate dorsally, biannulate ventrally, the second annulus of XI enlarged in the medial ventral field to encroach upon the first annulus of XII, and bearing the ♂ gonopore; on venter all clitellar annuli longer than those of the preceding somites; gonopores (Fig. 2) separated by two annuli, the ♂ on the caudal margin of XI *a3*, the ♀ at XII a2/*a3*, both small and obscure, especially the female, which on the type is concealed beneath the edge of projecting rim of somite XIII but on the paratype is exposed. Abdomen much wider than neck throughout, outline elliptical, the greatest width near middle at somites XVIII–XX (relatively much wider in the type) moderately depressed; cephalic end truncate but not expanded shoulderlike, embracing the last clitellar annulus, but prepucal fold only slightly developed; caudal end tapered to the sucker, for which it forms a definite peduncle; no lateral pulsatile vesicles and no other external metameric structures (nephropores, sensillae) discernible, except that intersegmental furrows are usually deeper than the others. Abdominal somites typically 3(6)-annulate but some of them definitely 6-annulate with the primary triannulation obscure, furrows often irregular or incomplete. Anus a well marked pore on the caudal peduncle followed by two incomplete annuli. Caudal sucker about twice size of cephalic in all dimensions, deeply cupped, regular, directed caudad, with about 48 minute marginal crenulations; dorsal face areolated and divided by faint furrows into three or four obscure concentric rings, each of which bears a circle of very minute papillae which are most distinct on the smooth ventral face No natural color remains, but the type is stained a uniform green, which may be due to preservation in a copper tank

Annulation (Fig. 1).—Often irregular and in places, especially at clitellum and caudal end of abdomen, difficult to interpret. On most somites primary and secondary furrows are distinguishable by their relative depth but in places this distinction is lost. I–V, cephalic sucker (head), no annuli distinguishable except some faint traces of one or two at caudal end. VI 2-annulate, first annulus (*a1 a2*) larger and very distinct, separated from sucker by a deep nuchal furrow, the second (*a3*) very small and not separated ventrally. VII 2 or 3-annulate, *a1* separated as a very short annulus on paratype, not distinct on type; furrows irregular and incomplete on both. VIII 3-annulate, similarly irregular, with split and spiral primary annuli. IX and X 3-annulate both dorsally and ventrally, *a3* largest on X with a faint secondary furrow. Normally X is first clitellar, but on these specimens apparently not closely united with XI externally. XI 2- or 3-annulate, definitely clitellar, (*a1 a2*) > *a3* with a faint *a1*/*a2* furrow on the dorsum, which disappears on the venter where *a3* is enlarged medially and produced caudad into XII as a small lobe bearing the ♂ gonopore on its caudal margin. XII 2- or 3-annulate, 3rd clitellar, similar to XI but shorter, more crowded, and partly concealed by XIII, *a1* less developed than on XI and *a3* possibly slightly subdivided, ♀ gonopore very minute at *a2*/*a3*, beneath prepucal fold on type. XIII 3-annulate, sharply defined by deep furrows from both XII and XIV and abruptly larger than former, with a moderately developed prepucal fold, which partly encloses it. XIV and XV 3-annulate, with *b5* and *b6* indicated on both paratype and type by a slightly developed *b5*/*b6* furrow and *b1* and *b2* on the former; owing to contraction the annuli of both crowded together and piled up, making the region very opaque. XVI–XXII normally 3(6)-annulate. The normal condition is that the three primary annuli are approximately equal and each divided by shallower furrows into two secondary annuli, but because of different degrees of contraction of the two specimens and of greater or less engorgement of different gastric caeca of the same specimen there is much irregularity. On the type specimen the triannulate condition dominates but the shallower secondary furrows are usually present, especially on the more contracted side, where annuli stand out more prominently, but *a3* is rarely and *a2* more frequently undivided. On the paratype XVI to XIX are much distended by the large blood-filled caeca, which stretch the integument so that it is thin and transparent and the distinction between primary and secondary furrows is nearly lost (Fig 1). This shows best on XVI and XVII. XVIII–XXII more typical, all annuli may be equal or *a2* smaller and *a3* larger. XXIII–XXV 3-annulate, but progressively reduced in size and the annulation very irregular, especially on the type XXVI and XXVII 2-annulate, but irregular, the latter much smaller and bearing the anus on the anterior margin of the first annulus.

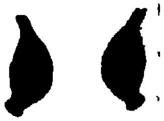


Fig 4.—*Austrobdella anoculata*: Dorsal and ventral photographic views of type × 3½.

Anatomy (Fig 3).—Some of the internal organs can be seen through the integuments sufficiently to determine their position and roughly their form, but the details were worked out from sections of the paratype in which some of the structures were obscured by the engorged gastric caeca. Anatomy closely patterned after that of the genotype, *A. translucens.* Ventral nerve ganglia of complete somites in annuli *a2*, chiefly in *b4*. Pharynx with medial ventral and paired dorsolateral muscular ridges; salivary glands diffuse, of very large single cells in somites VII–X Gastric caeca seven pairs in XIII to XIX, the first six reaching nearly to the lateral body walls and lobed at the ends, the last pair coalesced completely except at the caudal end, where the two caeca remain distinct for a longer distance than in *A. translucens;* intestine with two or three pairs of small simple caeca at the anterior end, following which it expands into a wide, simple sac reaching nearly to the end of the united gastric caeca and giving rise from its dorsal face a short distance anterior to its caudal end to a narrow, tubular rectum which ends at the anus. Reproductive organs similar to those of *A. translucens* except that the median chamber of the atrium is relatively smaller and the duct shorter; cornu large and sperm ducts with several loose coils at the atrial end; testes five pairs at XIV/XV to XVIII/XIX, alternating with gastric caeca. Vagina a simple vertical duct with only a slight enlargement and not expanded into a sac or bulb but encased in a mass of glands; it divides beneath the nerve cord into the paired ovarian sacs lacking the narrow duct and anterior lobe shown by Badham, both ovisacs very short, the one reaching to XIII only, the other to the middle of XIV, both containing developing ova in early stages.

Material examined.—Two specimens, one of which, the holotype, U.S.N.M. no. 20573, was obtained in 25 to 40 fathoms between Capes Alexander and Chalon, northwest Greenland, by Capt. Robert A. Bartlett, August 2, 1937 (station 27, seine haul). The other specimen, the paratype, comes from northeast Greenland, where it was collected by Captain Bartlett in 1930 (No. 14).

Remarks.—Owing to the limited material and its indifferent preservation, it has not been possible to arrive at such unequivocal conclusions and to prepare as satisfactory a description as could be wished. Many nominal species of fish leeches have been described from Arctic and sub-Arctic waters. Some of the early descriptions are so brief and ambiguous that the species to which they refer have never been certainly determined. Synonymies are still confused. It is possible that the species here described may belong to one of these, but none were found to agree. Concerning the generic reference there is little doubt. On a preliminary study it was thought that these leeches might belong to *Abranchus* or *Ottonia*, but externally the form and annulation differ from those genera and internally the coalescence of the last pair of gastric caeca is sharply differential.

On the other hand, the resemblance to *Austrobdella*, both externally and internally is very close. So far as it could be worked out, the annulation agrees closely with that of *A. translucens* Badham. The external form and proportions of parts are very similar. Neither of the two specimens is so strongly shouldered at the junction of the neck and abdomen as in Badham's most mature individuals. The anatomy of the alimentary canal and reproductive organs, so far as worked out, is very close in the two species, the principal differences being that in the type species the last pair of gastric caeca are more completely united at the caudal end than in *A. anoculata*, and that the ovisacs of the latter are not prolonged caudally and have the vaginal duct short and simple These ovarian differences may be due to immaturity. Owing to the state of the material, a study of the distribution of the sinuses was not attempted.

ICHTHYOLOGY.—Hadropterus palmaris, *a new darter from the Alabama River System.*[1] REEVE M. BAILEY. (Communicated by LEONARD P. SCHULTZ.)

In a collection of fishes from the Etowah River in northern Georgia, six specimens of a hitherto undescribed species of *Hadropterus* were taken. Twenty-seven additional specimens from two localities in Alabama have been placed at my disposal through the generosity of Dr. Carl L. Hubbs.[2] This handsomely colored species is herein described under the name *Hadropterus palmaris.*[3]

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[1] Received August 24, 1940. Journal Paper no J791 of the Iowa Agricultural Experiment Station, Ames, Iowa Project no. 651.

[2] I am indebted to Dr. Hubbs for helpful suggestions in preparing this paper.

[3] *Palmaris* = a prize.

Hadropterus palmaris, new species Fig. 1

Bronze Darter

Holotype.—An adult male (Univ. Michigan Mus. Zool. no. 126179), 65.5 mm in standard length, collected in the Etowah River, known locally as the High Tower River (tributary to the Coosa River, tributary to the Alabama River), just above the bridge at U. S. Highway 19, 4 miles southwest of Dahlonega, Lumpkin County, Ga., on August 25, 1939, by Reeve M. and Marian K. Bailey (field no. B39:59).

Paratypes.—Five specimens were taken with the holotype: U.M.M.Z. no. 126180 (2), U. S. National Museum no. 117881 (2), Iowa State College no. 1 (1). U.M.M.Z. nos. 111232 and 111133 (23) collected in Saugahatchee Creek (tributary to the Tallapoosa River), Ala., October 24, 1930, by F. E. Guyton. U.M.M.Z. no. 111234 (4) collected 3 miles east of Tuskegee, Macon County, Ala., June 3, 1931, by F. E. Guyton.

Diagnosis.—A highly colored species of *Hadropterus* with moderate sized scales, 59 to 73 (usually 69 or fewer) along lateral line; nape and cheeks fully scaled; opercles imperfectly scaled (especially in adults); and midventral scales greatly enlarged in males. Dorsal XI to XIV-10 to 13, the soft portion high; anal II, 7 to 10; and pectorals 13 to 15. Preopercle entire. Gill membranes separated; the distance from their union to insertion of pelvic fins 0.75 to 0.95 in distance from tip of mandible to union of gill membranes. Snout short, 3.6 to 4.4 in head length. No subocular dark bar; dorsolateral surface punctated with dark; 2 large light spots at base of caudal.

Description.—The various body proportions (Table 1), fin-ray and scale-row counts (Table 2), and the photograph (Fig. 1) indicate clearly many of the characteristics of the species. The juveniles are seen to differ from the adults in their larger eyes, shorter snouts, and the somewhat greater distance between the union of the gill membranes and the tip of the mandible, but variations in body proportions within the species appear to be slight. The apparently broader interorbital width in the Alabama specimens seems to be due to preservation. In most of the fin-ray and scale-row counts (Table 2) the Alabama and Georgia specimens agree rather closely; but in lateral-line scale count the range of variation in the Alabama specimens is greater (59 to 73) than in those from Georgia (59 to 63). The increased number of pectoral rays in the Georgia specimens (average 14.8) as contrasted with those from Alabama (average 13.7) is notable.

The preopercle is entire, the horizontal arm scarcely longer than the vertical arm. The premaxillary frenum is slightly narrower than the thick, terminal, upper lip, and about two-thirds the diameter of the pupil. The moderately heavy mandibles are well separated, diverging but little for about three-fourths of their length from the symphysis, behind which they flare outward more sharply. The mandibular frenum is somewhat wider than the premaxillary frenum. The snout is bluntly decurved; the upper edge of the upper lips is on the level of the bottom of the eye, and the lower jaw is slightly included. In I.S.C. 1 the gill-rakers number 3+11, of which 1 above the angle and 4 below are very short. The longest gill-raker when depressed scarcely extends to the base of the second raker below. In the same specimen the vertebral count is 18+23=41 (hypural included); in the first caudal vertebra no haemal spine is developed but the haemal processes are united. The vomer bears a strong cluster of teeth, and the palatines are strongly toothed along their length. In *H. nigrofasciatus* the palatine teeth are few and restricted to the anterior portion of the bones.

TABLE 1.—MEASUREMENTS (TAKEN WITH DIVIDERS) OF 10 SPECIMENS OF HADROPTERUS PALMARIS[1]

Measurement	1	2	3	4	5	6	7	8	9	10
	Etowah River, Lumpkin County, Ga			Saugahatchee Creek, Ala.	Etowah River, Lumpkin County, Ga		Saugahatchee Creek, Ala.	Etowah River, Ga	Saugahatchee Creek, Ala	
	U.M.M.Z	U.S.N.M	Holotype U.M.M.Z.	U.M.M.Z	I.S.C	U.S.N.M	U.M.M.Z.	U.M.M.Z.	U.M.M.Z	
	126180	117881	126179	111233	1	117881	111233	126180	111233	
Sex	♂	♂	♂	♀	♂	♂	♀	♀	♀	♀
Standard length in mm	68.5	67.5	65.5	63.5	63.0	61.5	61.0	46.5	38.0	36.0
In standard length										
Depth of body	5.15	5.1	5.35	5.2	5.2	5.6	5.4	6.0	5.3	5.8
Length of head, including opercular membrane	3.7	3.8	3.75	3.95	3.9	3.8	3.8	3.8	3.65	3.7
In length of head:										
Width of body	2.1	2.05	2.0	1.7	1.95	2.05	1.75	2.1	1.85	1.95
Depth of caudal peduncle	2.7	2.6	2.55	2.55	2.6	2.55	2.7	2.65	2.9	2.8
Highest dorsal spine	2.8	2.7	2.5	2.8	2.5	2.85	2.9	3.1	2.6	2.6
Highest dorsal soft ray	1.8	1.7	1.65	1.75	1.8	—	1.75	2.1	1.9	1.85
Highest anal ray	1.85	1.6	1.6	1.55	1.7	1.65	1.55	1.65	1.85	1.8
Longest caudal ray	1.6	1.45	1.4	1.5	1.55	1.35	1.35	1.35	1.35	1.35
Longest pectoral ray	1.05	.95	.95	1.0	.95	1.0	1.05	1.0	1.1	1.0
Length of pelvic fin	1.1	1.05	1.05	1.15	1.1	1.1	1.2	1.1	1.2	1.2
Depth of head	1.6	1.6	1.65	1.65	1.6	1.7	—	1.8	1.8	1.7
Width of head	1.6	1.45	1.7	1.75	1.7	1.75	1.7	1.8	1.85	1.8
Length of eye	4.9	4.7	4.5	4.5	4.4	4.5	4.6	4.1	3.85	3.9
Length of snout	3.6	3.95	4.0	4.0	3.95	4.1	3.8	4.1	4.4	4.4
Length of upper jaw	3.4	3.6	3.7	3.4	3.65	3.7	3.4	3.7	3.85	3.75
In length of snout:										
Length of eye	1.4	1.2	1.15	1.1	1.15	1.1	1.3	1.0	0.95	0.95
In length of eye:										
Least fleshy interorbital width	1.5	1.5	1.6	1.25	1.7	1.5	1.35	1.6	1.5	1.45
In distance from tip of mandible to union of gill membranes:										
Distance from insertion of pelvic fin to union of membranes	0.85	0.75	0.8	0.8	0.8	0.85	0.85	0.95	0.95	0.9
Length of eye	2.4	2.3	2.2	2.2	2.15	2.35	—	2.2	1.85	1.95

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[1] Largely following the format employed by Hubbs and Raney (1939, pp 5–6) in their description of *H oxyrhynchus* (Occ. Pap Mus. Zool Univ Mich no 396, pp. 1–9, pl. 1)

Table 2.—Frequency Distributions of Fin-Ray and Scale Counts[1] on Hadropterus palmaris (the counts of the holotype are indicated by asterisks)

Locality	Dorsal spines				Dorsal soft rays[2]				Anal soft rays[2]				Caudal branched rays[3]		
	11	12	13	14	10	11	12	13	7	8	9	10	13	14	15
Georgia	—	1	5*	—	—	2	4*	—	—	1	5*	—	—	2	4*
Alabama	1	10	15	1	1	18	6	2	2	12	10	3	1	19	7
Total	1	11	20	1	1	20	10	2	2	13	15	3	1	21	11

Locality	Pectoral rays (both sides)			Scale rows							
				Above lateral line			Below lateral line				
	13	14	15	7	8	9	10	11	12	13	14
Georgia	—	3*	9*	1	5*	—	3	2*	—	1	—
Alabama	16	36	2	1	20	6	3	2	8	12	2
Total	16	39	11	2	25	6	6	4	8	13	2

Locality	Scale rows																				
	Along lateral line															Around caudal peduncle					
	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	20	21	22	23	24	25
Georgia	2*	—	1	—	3	—	—	—	—	—	—	—	—	—	—	—	2	1	2*	1	—
Alabama	1	5	2	2	1	5	2	3	1	1	2	1	—	—	1	1	6	4	13	2	1
Total	3	5	3	2	4	5	2	3	1	1	2	1	—	—	1	1	8	5	15	3	1

[1] The scales above the lateral line were counted downward and backward from the origin of the second dorsal fin, those below the lateral line were counted upward and forward from the origin of the anal fin, those along the lateral line were counted to the base of the caudal rays, those around the caudal peduncle represent a minimum enumeration

[2] The last ray of the soft dorsal and anal fins was counted as double at the base

[3] Seventeen principal caudal rays were counted in all specimens

Five pores are given off by the lateral canal of the head, the anterior from a short downward projecting tube and the next three at the tips of long slender tubes, which project downward and backward. The supratemporal canal is complete, giving off a median pore from a short backward projecting tube, and one lateral pore on each side from longer and slenderer tubes that project backward and slightly downward. A single postorbital pore opens from a short backward projecting tube from the supraorbital canal on each side, and the interorbital pore of each side opens from a short tube that projects outward or outward and backward. The posterior nasal pore opens from a short tube just above the anterior end of the slitlike, posterior nostril. The anterior nasal pore lies anterodorsal to the tubular, anterior nostril. The coronal pore opens at the end of a long tube which may be curved slightly to the left or right. The infraorbital canal is complete with 8 pores; of which the anteriormost lies below and behind the anterior nostril, the second and third open from slender tubes near the edge of the maxillary groove, the fourth emerges from a short upward projecting tube, and the posterior four open from long slender tubes that project downward and backward. Of the ten operculomandibular pores the six on the preopercle open from short, side tubes. The complete lateral line is very slightly arched anteriorly. (Nomenclature of canals and pores from Hubbs and Cannon, p. 10, pl. 2.[4])

The genital papilla of the adult male is a depressed and rounded, conical projection, which is smooth except for a short, longitudinal groove near its tip; that of the female is broadly semicircular, with several deep grooves radiating forward and outward from the orifice.

The pelvic fins are separated by a space equal to about four-fifths of the pelvic base. Between the pelvics there are two or three enlarged median scales, which may or may not be followed posteriorly by a naked strip for two-fifths of the length of the pelvic fins. In males the remainder of the midline of the belly is provided with a series of greatly enlarged scales with long and very strong ctenii; in females these scales are scarcely or not at all enlarged and the ctenii are little developed. There are one or two slightly to moderately enlarged scales at the union of the pelvic bones near the middle of the breast, and the subtriangular area between the pelvic bones is provided with small imbedded scales; otherwise the breast is entirely naked. The nape and cheeks are covered with well-developed imbricating scales; those of the cheek are in seven or eight rows as counted from the eye to the posteroventral angle of the preopercle. The opercles are provided with deciduous scales, varying from a complete absence of scales in some of the larger adults to an almost complete covering in juveniles. The holotype has five small, nonimbricate, imbedded scales on the left opercle and nine on the right.

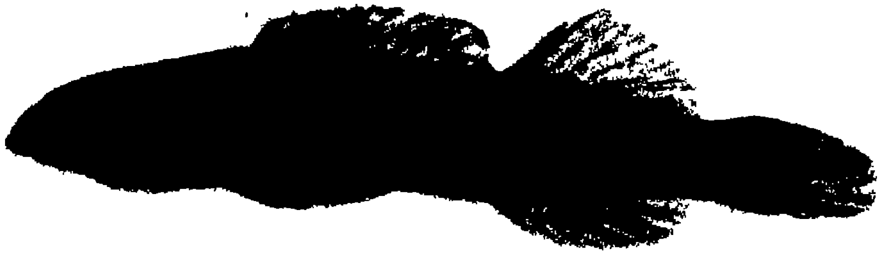

Fig. 1.—Paratype of *Hadropterus palmaris*, U.S.N.M. 117881, an adult male 67.5 mm in standard length, from the Etowah River, Ga. The photograph, of the right side of the fish but reversed in printing, was taken by Max E. Davis.

The spinous dorsal is long and rather low and is narrowly separated from the soft dorsal. The soft dorsal and anal are large. The first of the two anal spines is much stronger but slightly shorter than the second. The margin of the caudal is slightly concave. The pectorals are broadest near their middle and extend as far back as the pelvics.

Coloration.—With the exception of *evides*, *palmaris* is the most colorful and handsome species of *Hadropterus* thus far described. In life the bodies of adult males were deep yellowish brown above, shading to dull olivaceous on the breast. On each side were eight to ten dark greenish-black vertical bars

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[4] *The darters of the genera* Hololepis *and* Villora. Misc. Publ. Mus. Zool. Univ. Michigan, 30: 1–93, pls. 1–3. 1935.

(which retained their color in preservation), each considerably wider than the interspaces. These bars are usually continuous with their fellows across the back, especially anteriorly; and each narrows and fades ventrally, failing to cross the midventral line; those on the caudal peduncle extend somewhat lower than those on the body. In females the lateral blotches are longer than high and fail to ascend high on the sides. The bands are scarcely in contact with one another along the lateral line in some places; in others the contact is equal to the eye's breadth The cheeks and lower portions of the opercles were (in life) dull yellowish green. The throats were iridescent with bluish-purple reflections; in preservation they are faintly dusky but less so than the mandibles. Unlike most species of the genus *Hadropterus* there is no trace of a subocular dark bar. A narrow dark band extends forward from the middle of the eye through the nostril, usually joining with that of the opposite side across the frenum. A dark bar extends backward from the eye across the upper part of the cheek to the anterodorsal corner of the opercle. A few dark spots are scattered on the dorsolateral surfaces of the back of the head, and somewhat larger dark spots are present between the lateral bars on the dorsolateral surfaces of the body.

In life the spinous dorsal was light near the base, with a rich chocolate-brown spot on each interradial membrane. This light area was succeeded distally by a dusky band, which shaded gradually into a rich reddish-orange band occupying most of the distal half of the fin, which was sharply and narrowly edged with clear white. In preservation the white edging and the dusky band are evident in the otherwise uniformly faint pigmentation. The soft dorsal was dull orange-yellow, with a narrow light border; a few scattered dark radial spots tend to form rows about one-third and two-thirds of the distance from the base, but in some specimens they are faint or obsolete. At the base of the caudal there are two large light spots (each about size of eye), which were pale yellowish orange in life. Three wavy vertical bars on the caudal are formed by pigment confined to the rays. The caudal, anal, pectorals, and pelvics were suffused with dull yellow in life, and all had light distal edges. In preservation the basal half of the anal is faintly dusky; the pelvics have a few median dusky spots; and each pectoral has a narrow curved bar just proximad of the middle

The color description given above was drawn from the Georgia specimens. Juveniles from Saugahatchee Creek, Ala , vary greatly in body pattern. Some differ but little from the adults, whereas others are heavily and irregularly mottled with dark on the sides and the lateral series of blotches are scarcely or not at all developed.

Habitat.—The Etowah River is an upland stream (elevation at site of collection about 1,300 feet), which at the time of the collection was clear, colorless, cool (67° F.), and with a moderate to swift current. It varied from about 35 to 60 feet in width, and the flow, estimated at 250 cubic feet a second, was somewhat greater than normal owing to recent rains. The bottom was composed largely of sand, with coarse gravel and slab-rubble riffle areas. Vegetation was limited to slight algal growth on the stones.

All the specimens of *H. palmaris* were taken on a swift riffle, which was about 6 feet long and extended the width of the stream. It varied from a few inches to over a foot in depth. Common associates of *H. palmaris* on the riffle were *Poecilichthys jordani* and *Cottus zopherus* (probably this species although the lateral line is nearly or quite complete). Other species taken in the collection were *Moxostoma* sp., *Hypentelium etowanum*, *Notropis callistius*, *N. x. xaenocephalus*, *N. trichroistius*, and *Micropterus coosae*. Local residents reported that rainbow trout occurred in the stream, but none were collected. No habitat data are available for the Alabama collections.

Relationships.—*H. palmaris* differs trenchantly from all other known species in the genus in coloration and color pattern; especially distinctive are the pattern of the spinous dorsal, the uniform absence of a subocular bar, and the presence of dark spots on the anterior back and of two round light spots at the base of the caudal. It differs from *macrocephalus*, *phoxocephalus*, and *oxyrhynchus* especially in the blunter snout, the shorter distance from the tip of the snout to the union of the gill membranes (see Hubbs and Raney, loc. cit.), and in the larger scales In its entire preopercle, *palmaris* contrasts with *H. scierus*. The Atlantic drainage species, *peltatus* and *roanoka*, differ from *palmaris*, among other respects, in the larger scales and in the absence of scales on the nape. *H maculatus* and *H palmaris* are quite similar in form, although in *maculatus* the soft dorsal and anal are much lower, but *maculatus* typically lacks scales on the predorsal area, and has more perfectly scaled opercles than *palmaris*. On the basis of color pattern *H. palmaris* is separable at a glance from *H. nigrofasciatus*, the only other described species of the genus from the Alabama basin It also differs from that species in the imperfect squamation of the opercles, the much larger and more specialized midventral scales of the males, and in the stronger fin spines, especially the first anal spine Although *palmaris* lacks the characteristic subocular dark bar of *evides*, the two species share certain features of coloration. Both have paired light spots at the base of the caudal, lateral blotches which are similar in shape and color and agree in continuing upward to cross the back, and each is highly colored in life *H evides* is a heavier and more robust species, and in it the spinous dorsal is conspicuously higher and more rounded, and the soft dorsal lower than in *palmaris*. The absence of cheek scales in *evides* and the imperfect squamation of the opercles in *palmaris* are clear-cut differentiating features.

H. palmaris seems to share more similarities with *evides* than with other species, the two apparently standing somewhat apart from the remaining species in the genus.

ICHTHYOLOGY.—*The remora* Phtheirichthys lineatus *and the first specimen from United States waters.*[1] Hugh M. Smith, U. S. National Museum.

In the year 1791 there appeared two descriptions of a new remora called *Echeneis lineatus* by Archibald Menzies in Transactions of the Linnean Society, London (vol. 1, p. 187, pl. 17, fig. 1), and *Echeneis tropica* by Bengt Anders Euphrasén in Kongliga Vetenskaps Academiens Nya Handlingar, Stockholm (vol. 12, p. 317). The habitat of *E. lineata* was stated to be the Pacific Ocean between the tropics, and the single specimen 5 inches long on which the description was based was found adhering to a turtle. For *E. tropica* the locality given was latitude 2° 9′ N., longitude 20° 49′ W. from Paris, a place in the Atlantic Ocean about 600 miles southwest of that part of Africa now known as Liberia, and the single specimen mentioned was discovered attached to the nautical log of a ship when the log was pulled aboard.

These two names have generally been regarded as applying to the same species, and there is certainly nothing in the original descriptions to indicate specific distinctness. The outstanding character is the possession of only 10 laminae in the cephalic disk, combined with features that are shared with the common remora *Echeneis naucrates*, such as the very elongate body, ventral fins narrowly adnate to the abdomen, angulate pectoral fins, middle caudal rays produced in the young, and strongly projecting lower jaw with a cutaneous symphyseal flap. In 1862 Gill (Proceedings of the Academy of Natural Sciencies of Philadelphia) created the genus *Phtheirichthys* and designated *Echeneis lineata* Menzies as the type.

With two specific names for the same fish coming into use in the same year, there arises the question of the proper one to adopt. While the question may not be definitely settled by the internal evidence afforded by the respective publications, there is ground for a reasonably satisfactory decision affecting both priority and convenience.

The Nya Handlingar in which Euphrasén's *Echeneis tropica* was described (in a paper entitled "Scomber atun och Echeneis tropica beskrisne") was issued in quarterly parts with consecutive pagination, the paper appearing in the part for October, November, and December 1791. It is improbable that the part was printed and distributed before the last quarter of 1791; it is possible that it was not issued until the last month of that quarter or even the beginning of the next quarter.

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[1] Published by permission of the Secretary of the Smithsonian Institution. Received September 25, 1940.

Menzies's paper, "Description of Three New Animals Found in the Pacific Ocean," was read before the Linnean Society on April 6, 1790, and was followed by papers by other authors read in October, November, and December, 1790, and March, 1791, and was preceded by papers read in 1788, 1789, and 1790, with an addendum to one of the papers bearing date of February 6, 1791. The plate accompanying the paper contains, in addition to a figure of the remora, figures of a worm and a leech described by Menzies and four figures of insects referred to in a paper by another author. The make-up and general appearance of the volume strongly indicate that it was published as a whole, and there is nothing to suggest that any of the papers were issued as separates; indeed, such issuance was practically precluded by the fact that figures illustrating papers by two different authors appeared on the same plate. The title page of the volume bears date of 1791, and it may be safely inferred that the volume was issued in the first half of that year.

But even if it can not be conclusively shown from the evidence at hand that the name *Echeneis lineatus* has priority over *Echeneis tropica*, it may be proper, and it is certainly desirable, to render a decision in favor of the former because the description was accompanied by an illustration and because *lineatus* was designated as the type of a new genus.

The first mention of this fish as an inhabitant of the coastal waters of the United States was by Jordan and Gilbert (Proc. U. S. Nat. Mus. **5**:591. 1882), who recorded a specimen 4 inches long taken by Gilbert at Charleston, S. C., in July–August, 1882. This specimen, apparently no longer in existence, was fully described and was the basis for the statement in Jordan and Gilbert's *Synopsis of the fishes of North America* (1883) that the species ranges in "tropical seas, north to South Carolina." In Jordan and Evermann's *Fishes of North and Middle America* (part 3, 1898) the species is reported to range also to Pensacola, although in Evermann and Kendall's *Check-list of the Fishes of Florida* (1900), which included "all salt-water species known from Florida within the depth limit of 1,000 fathoms," this remora is not listed. In the *Check List of Fishes and Fishlike Vertebrates of North and Middle America* (1930), by Jordan, Evermann, and Clark, the species appears under the name *Phtheirichthys tropicus*, without mention of *P. lineatus* as a synonym.

It now remains to present a record of what appears to have been the first specimen of *Phtheirichthys lineatus* taken in United States waters. A short time ago Dr. Leonard P. Schultz, curator of fishes in the United States National Museum, found in the National collection a fish labeled *Rhombochirus osteochir*, which proved to be a *Phtheirichthys* indistinguishable from the form described and figured by Menzies. The specimen came from Woods Hole, Mass., was obtained in 1871 by Vinal N. Edwards, the indefatigable collector of the United States Fish Commission, and was catalogued in 1876, bearing the number 20331 in the Museum register. In view of my special interest in the fish fauna of the Woods Hole region, Dr. Schultz has kindly permitted me to make known the existence of this specimen, which is apparently the first and only one reported from our northeastern coast. The specimen, in an excellent state of preservation, is 15.6 cm long, with discal laminae numbering 10, dorsal rays 31, and anal rays 30, and, although nearly 60 years in alcohol, it still shows the two whitish longitudinal stripes along the side as represented in Menzies's plate and embodied in his specific name.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE ACADEMY

363D MEETING OF THE BOARD OF MANAGERS

The 363d meeting of the Board of Managers was held in the Board Room of the Cosmos Club on Friday, October 11, 1940. President Crittenden called the meeting to order at 8:03 p.m. There were 15 present, as follows:

E C Crittenden
F D. Rossini
F C Kracek
H S. Rappleye
H C Fuller
J H Hibben
G. Steiner
F M Setzler
A. T. McPherson
A H. Clark
C. Thom
W. Ramberg
E W Price
C L Garner
and by invitation
J. H. Kempton

President Crittenden appointed the following Committee of Tellers to count the ballots on the three proposed amendments to the bylaws, which were submitted to vote of the membership on October 7: H. N. Eaton, chairman; R. S. Jessup; B. J. Mair; Charles Moon, alternate.

Chairman Garner reported for the Committee on Meetings that the following program of meetings has been arranged for the Academy for the season October to April, inclusive:

October 17, 1940 Dr. W. F G. Swann, director of the Bartol Research Foundation of the Franklin Institute, Swarthmore, Pa., on "The Laws of Nature."

November 28, 1940. Dr. Vergil Reed, assistant director of the U. S. Bureau of Census, on "The Human Side of the Census."

December 19, 1940. Dr. W C. Lowdermilk, chief of the Division of Research of the U. S. Forest Service Title not yet announced.

January 16, 1941. Annual meeting and presidential address.

February 20, 1941. Dr. P. W. **Bridgman**, professor of physics at Harvard University, Cambridge, Mass. Title not yet announced
March 20, 1941. Awards for scientific achievement
April 17, 1941 Tentatively, Commander F. W. **Reichelderfer**, chief of the U. S. Weather Bureau.

The date for the November meeting was changed to the 28th because the 21st is Thanksgiving Day. The October and November meetings are scheduled to be held in the Assembly Hall of the Cosmos Club, as in the past. Commitments for the following months will be made later.

On recommendation by the Committee on Membership, who submitted the names at the last meeting of the Board, 17 persons were considered individually and duly elected to membership.

Mr. **Setzler** presented the report of the Special Committee, of which he is chairman with R. E. **Gibson** and R. R. **Spencer** members, on Society Affiliation with the Academy. The committee considered the list, published in Vol. 30, No. 1, Jan. 15, 1940, of the **Journal**, of societies not affiliated with the Academy and recommended action on organizations representing disciplines having a small active stable membership within the District of Columbia. The report was accepted by the Board, and the committee was instructed to report in detail on the Washington Section of the American Institute of Mining and Metallurgical Engineers; the Washington Chapter of the American Institute of Metals, and the Washington-Baltimore Psychoanalytic Association.

The secretary reported the following status of Academy membership:

	Resident	*Nonresident*	*Total*
Active	420	127	547
Retired	30	13	43
Honorary	3	14	17
Patrons	—	2	2
Total	453	156	609

Cognizance being taken of present commitments in the form of nominations, acceptances, etc., there is a minimum of 22 vacancies in the resident membership and of 5 in the nonresident membership.

The Board adjourned at 9:18 P.M.

ELECTIONS TO MEMBERSHIP

The following were recently elected to resident membership:

Ernest Adna Back, principal entomologist, U. S. Bureau of Entomology and Plant Quarantine, in recognition of his contributions relating to the control of attacks of insects on stored products and to the biology and control of citrus white flies.

Nathan Lincoln Drake, professor of organic chemistry, University of Maryland, in recognition of his contributions to organic chemistry, in particular his researches on the constitution of the polyterpenoids.

Lyndon Frederick Small, head chemist, National Institute of Health, in recognition of his studies on morphine derivatives.

R. **Clifford Hall**, principal forester, U. S. Forest Service, in recognition of his researches and investigations on forest policy and forest tax problems.

Walter J. Hamer, associate chemist, National Bureau of Standards, in recognition of his work on hydrogen ion concentration, in particular his investigations on the thermodynamics of sulphuric-acid solutions and the development of a pH method using galvanic cells without liquid junctions.

Verne Lester Harper, senior silviculturist, U. S. Forest Service, in recognition of his contributions to oleoresin production in pines, in particular the effect of weather and soil factors on gum flow.

Jay P Kinney, supervisor of work program, Indian Service, U. S. Office of Indian Affairs, in recognition of his contributions to forest law and history and to the improvement of forest management on Indian lands.

Jacob Kotz, clinical professor of obstetrics and gynecology, George Washington University, in recognition of his contributions to endocrinology.

Joseph Thomas Pardee, senior geologist, U. S. Geological Survey, in recognition of his contributions to the geology of metalliferous deposits (including manganese) in the Northwestern States.

Elizabeth Parker Bartsch, physician, clinical instructor in obstetrics and gynecology, George Washington University, in recognition of her researches in female endocrinology.

Raymond Price, senior forest ecologist, U. S Forest Service, in recognition of his researches relating to forest and range lands, particularly in connection with range management, artificial revegetation, and plant nutrition

Frederic G Renner, chief of the division of range conservation, U S. Soil Conservation Service, in recognition of his researches on erosion control and watershed protection on forest ranges and other range lands.

Oscar William Torreson, observer, Department of Terrestrial Magnetism, Carnegie Institution of Washington, in recognition of his investigations in atmospheric electricity

Richmond Tucker Zoch, associate meteorologist in charge of library, U. S. Weather Bureau, in recognition of his contributions to mathematical hydrology.

The following was recently elected to nonresident membership:

George Burton Rigg, professor of botany, University of Washington, Seattle, Wash., in recognition of his contributions to plant physiology, in particular his researches on the physiology and ecology of sphagnum-bog vegetation.

CHEMICAL SOCIETY

512TH MEETING

The 512th meeting was held in the School of Government Building of George Washington University on Thursday, October 12, 1939, President **Kracek** presiding After the completion of routine business the following communications were presented in three sections:

Inorganic and Analytical Chemistry, C. R **Naeser** presiding

F. W. Schwab and **E Wichers**: *The Preparation of Benzoic Acid of High Purity.*

A. K. Brewer: *A Thermal Method for the Separation of Isotopes.*

F. W. Glaze and **A. N. Finn**: *A Modification of the Partition Method for Determining Boron in Glass.*

Organic and Biological Chemistry, C. M. **Mackall** presiding

L. D. Goodhue and **H. L. J. Haller**: *Recent Progress in the Chemistry of Derris.*

M. B. Matlack: *The More Important Aspects of Our Work on Lipase and Esterase.*

L. A. Shinn and B. H. Nicolet: *The Action of Periodic Acid on Amino Alcohols and Amino Acids.*

Physical Chemistry, M. H. Van Horn presiding

S. Brunauer and P. H. Emmett: *Chemisorptions of Gases on Iron Synthetic Ammonia Catalysts.*

A. Brenner: *The Electrodeposition of Copper-Bismuth Alloys from a Perchlorate Bath.*

C. K. Horner and D. Burk: *The Catalytic Function of Molybdenum in Nitrogen Fixation by Azotobacter.*

513TH MEETING

The 513th meeting was held in the auditorium of the East Building of the National Bureau of Standards on October 26, 1939, President Kracek presiding. Following the completion of routine business, the Society was addressed by H. Mark, formerly of the University of Vienna, on *The Elastic Behavior of High Polymeric Substances.*

514TH MEETING

The 514th meeting was held in the auditorium of the Cosmos Club on November 9, 1939, President Kracek presiding. The Society was addressed by Earl P. Stevenson, president of Arthur D. Little Co., of Cambridge, Mass., on the subject *Research in Industry.* Elections were held for the officers for the Society for the year 1940. The following were elected: President, R. M. Hann; Secretary, Norman Bekkedahl; Treasurer, E. R. Smith; Councilors, F. G. Brickwedde, N. L. Drake, R. Gilchrist, H. T. Herrick, G. E. Hilbert, B. H. Nicolet, B. D Van Evera; Managers, M. M. Haring, S. B. Hendricks, J. T. Scanlan, S. T. Schicktanz, L. A. Shinn, H. P. Ward.

515TH MEETING

The 515th meeting was held in the auditorium of the Cosmos Club on November 30, 1939, President Kracek presiding. Following the completion of routine business, the Society was addressed by Robert E. Lutz, of the University of Virginia, on *Some Recent Work on Furans and Hydroxyfuranones*

516TH MEETING

The 516th meeting was held in the auditorium of the Cosmos Club on December 14, 1939, President Kracek presiding. Following the completion of routine business, the Society was addressed by W. Frankenburg on *Relations Between Photochemical and Catalytic Processes.*

517TH MEETING

The 517th meeting was held jointly with the Washington Academy of Sciences in the auditorium of the Cosmos Club on December 21, 1939. The President of the Academy, Charles E. Chambliss, introduced B. F. Nicolet, Resident Vice-President of the Academy, who presented the speaker of the evening, C. S. Marvel, professor of organic chemistry of the University of Illinois. Dr. Marvel addressed the meeting on *Plastic Glasslike Resins (Vinyl Polymers).*

518TH MEETING

The 518th meeting (56th annual meeting) was held in the auditorium of the Cosmos Club on January 11, 1940, President **HANN** presiding. After the reading of reports of the officers and committees for 1939 and the completion of other routine business, the Society was addressed by the retiring President, **FRANK C. KRACEK**, who spoke on *Some Chemical Aspects of Order-Disorder Phenomena.*

519TH MEETING

The 519th meeting was held in the auditorium of the Cosmos Club on February 8, 1940, President **HANN** presiding. Following the completion of routine business, the Society was addressed by **L. MICHAELIS**, of the Rockefeller Institute for Medical Research, New York City, on *Reversible Oxidation-Reduction in Organic Compounds and Semiquinone Radicals.*

520TH MEETING

The 520th meeting was held in the auditorium of the Cosmos Club on March 14, 1940. The occasion was the annual banquet of the Society, and 119 members and guests gathered together to celebrate the awarding of the Hillebrand Prize to **R. E. GIBSON**, of the Geophysical Laboratory, Carnegie Institution of Washington, for this excellent work, *The Behavior of Solutions Under High Pressures.* President **HANN** acted as Toastmaster. He first introduced **L. H. ADAMS**, the director of the Geophysical Laboratory, who spoke on *Some Significant Aspects of High-Pressure Research.* Following this, Past-President **KRACEK** introduced the recipient of the award, Dr. **GIBSON**, who was then presented with the certificate by Dr. **HANN**. Dr. **GIBSON** then addressed the Society, giving a résumé of his work in the field of the behavior of solutions under high pressures.

521ST MEETING

The 521st meeting was held in the auditorium of the Cosmos Club on March 28, 1940, President **HANN** presiding. Following the completion of routine business, the Society was addressed by **PHILLIP ABELSON**, of the Department of Terrestrial Magnetism, Carnegie Institution of Washington, who spoke on *Indentification of the Products of Uranium Fission.*

522D MEETING

The 522d meeting was held in the auditorium of the Cosmos Club on April 11, 1940, S. B. **HENDRICKS** presiding in the absence of President **HANN** The Society was addressed by two members of the National Institute of Health:

SANFORD M. ROSENTHAL: *Experimental Studies upon Sulphanilamide and Related Compounds.*

HUGO BAUER: *Chemical Structure of Some Arsenic and Phosphorous Compounds Active against Bacterial Infections.*

523D MEETING

The 523d meeting was held in the auditorium of Engineering Building, University of Maryland, College Park, Md., President **HANN** presiding. H. S. **ISBELL** and C. E. **WHITE** were elected to the Board of Managers to fill vacancies arising from the resignations of J. T. **SCANLAN** and S. T. **SCHICKTANZ**. After the completion of other routine business, the following communications were presented in three sections:

Physical Chemistry, M. M. HARING presiding

J. STEINHARDT and M. HARRIS: *Role of Anions and of Undissociated Acids in the Combination of Acids with Proteins.*

D. V. SICKMAN and W. P. RATHFORD: *Induced Chains and the Mechanism of the Thermal Decomposition of Acetaldehyde.*

E. R. SMITH: *Limitations of the Polarographic Method of Analysis.*

Organic and Biological Chemistry, N L DRAKE presiding

W. H. SEBRELL and F. S. DAFT: *Vitamin B_2 Complex Deficiencies.*

J J. STUBBS, L. B. LOCKWOOD, E. T. ROE, B. TABENKIN and G. E. WARD: *Production of Ketogluconic Acids from Glucose by Acetic-Acid Bacteria.*

S. N. WRENN and C. I. POPE: *Reaction of Acetals with Anhydrous Hydrogen Bromide.*

Analytical and Inorganic Chemistry, W J SVIRBELY presiding

C. E. WHITE: *Fluorescence Analysis of Aluminum and Thorium.*

W. D. MOGERMAN and J. A. SCHERRER: *Determination of Tin in Nonferrous Alloys by the Distillation-Cupferron Method.*

W. O. ROBINSON: *The Occurrence of Rare Earths in the Leaves of Hickory and a Few Other Plants.*

NORMAN BEKKEDAHL, *Secretary*

BOTANICAL SOCIETY

301ST MEETING

The 301st regular meeting was held in the assembly hall of the Cosmos Club, December 5, 1939, Vice-president CHARLOTTE ELLIOTT presiding; attendance 100.

Notes and reviews.—M. B. WAITE called attention to the fact that he had found a butternut tree (*Juglans cinerea*) growing on the Coastal Plains, near Walshs Grove, 1 mile from Priests bridge on the Patuxent River. He also displayed a puffball, *Calastoma cinnabarinum*, which he had collected on his farm growing among sphagnum and ferns and a rare climbing fern, *Lygodium palmatum*, which was growing in his apple orchard among dead golden-rods. It is related to *Schizaea.*

Program.—PHILLIP BRIERLY: *Mosaic of lilies.*—Two viruses can be isolated from Easter lilies (*Lilium longiflorum* Thunb.) affected with necrotic fleck mosaic: A strain of cucumber virus I and a virus similar to McWhorter's latent virus of lily. Tulip viruses such as McWhorter's latent type fail to infect tobacco, and cucumber-virus strains are not recovered when necrotic fleck is passed through tulip. Tulips inoculated with cucumber virus develop leaf and flower symptoms distinct from the usual breaking of tulips. Easter-lily seedlings show mild symptoms or none following inoculation with latent virus only, and none with cucumber virus only; under some conditions they develop fleck when cucumber virus is superimposed on latent virus. The coarse mottle mosaic of Easter lily yields a tulip virus but no cucumber virus. *Lilium formosanum* Stapf expresses symptoms on inoculation with tulip viruses including that which is latent in Easter lily and other species. This species is a convenient substitute for tulip in indexing lilies for the presence of tulip virus. With this species and tobacco used as test plants, cucumber and tulip viruses have been shown generally distributed both separately and in double infections in many lily species in gardens.

CHARLES THOM: Address of the retiring president, *Naming molds*, published in full in this JOURNAL, vol. 30, no. 2, February 15, 1940.

ALICE M. ANDERSEN, *Recording Secretary*

Obituary

Frederick Eugene Fowle was born in Arlington, Mass., on November 20, 1869, the son of Frederick E. and Mary Proctor Fowle. He died at Washington, D. C., on April 23, 1940. A precocious youth, he early undertook the study of music and languages, becoming proficient in both. His formal education was completed at the Massachusetts Institute of Technology, from which he was graduated in 1894.

As a young man he was for several years assistant at the Harvard College Observatory, but after graduation from the Massachusetts Institute of Technology he accepted a position at the Smithsonian Institution, where he spent more than 40 years in the measurement and study of the radiation of the sun. He was coauthor in Volumes 1 to 5 of the Annals of the Astrophysical Observatory, and he devised methods of measuring the total atmospheric contents of water vapor and of ozone. He made valuable researches on the influence of these vapors on the income and outgo of radiation through the atmosphere which will long be referred to. Not less valuable was his assembly and editorship of the Smithsonian Physical Tables, a reference work that he made invaluable in these days of rapid discovery of the physics of the atom and the extension of the universe. Nearly 20,000 copies of this book went into the hands of research men during his editorship, and received universal praise for broadness and accuracy.

By his first wife, Susie Gates, of Arlington, Mass, Mr. Fowle had two children, who survive him. In 1930 he married Juliana Thomasson, of North Dakota, who also survives him.

Francis Randall Hagner died suddenly on July 7, 1940, at his home, 1824 Nineteenth Street, NW., Washington, D. C. Dr. Hagner was born in Washington in 1873, the son of Dr. Charles E. and Mrs. Isabella Davis Hagner. His family had long been prominent in the affairs of Maryland and the District of Columbia. He received his preliminary education at the Emerson Institute. In 1894 he was graduated from the School of Medicine of the Columbian College, now George Washington University. After graduation he went to Johns Hopkins Hospital, becoming assistant resident in surgery. In 1896 he returned to Washington to practice medicine. For a time he carried on a general practice, but after a few years he began to specialize in urology.

He was appointed professor of genitourinary surgery at the George Washington University School of Medicine in 1905, which position he held until his retirement in 1939 when he became professor emeritus. Dr. Hagner will be remembered as a successful teacher and leader in his field. Many of his students through his influence, have specialized in the field of urology.

Many honors came to him in the field of medicine, and he served as president of the American Association of Genitourinary Surgeons, the Clinical Society of Genitourinary Surgeons, the Clinico-Pathological Society of the District of Columbia, and the Medical Society of the District of Columbia. He was a life member of the American College of Surgeons, a fellow of the American Medical Association, and a member of the American Urological Association and the Southern Surgical Association.

Dr. Hagner invented numerous devices and made marked advances in procedures involved in his specialty and wrote many medical articles relative to it.

Among Dr. Hagner's many interests one of the outstanding was his prolonged and thorough study of the life of John Wilkes Booth and of the circumstances surrounding the assassination of President Lincoln. He was deeply interested in the collection of etchings and early Western Americana. He was a member of the Washington Academy of Sciences, the Biological Society of Washington, and the Columbia Historical Society.

He was possessed of a charming personality which won him hosts of friends and admirers both in Washington and wherever he was known. He was one of the most beloved as well as one of the most distinguished physicians of our time.

Dr. Hagner married Miss Elizabeth Allemong of Charleston, W. Va., in 1898. She and a sister, Mrs. Norman James of Baltimore, survive him.

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